HEIDENHAIN

Operating Instructions

ND 2100G
GAGE-CHEK

Software Version
2.60.x

ND 2100G Introduction

1 LCD screen
2 Soft keys
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4 Command keys
5 Arrow cursor keys
6 Numeric Keypad
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8 Send key
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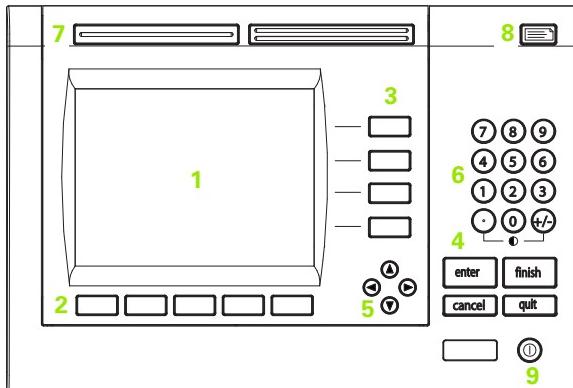
ND 2100G panel keys

Panel keys are used to initiate feature measurements, apply tolerances, send reports of measurement results and configure operational parameters.

Panel function key	Panel key
Soft keys: Functions change in support of the activities displayed on the LCD.	
Dimension keys: Can be assigned one of six hot key functions for use when DRO screen is displayed. When graph, bar value or data screens are displayed, dimension keys are used to display values for single dimensions or a smaller group of dimensions.	
Command keys: Control measurement and data entry processes.	enter finish cancel quit
Arrow cursor keys: Used to scroll through lists and navigate menus and setup screen data fields.	
Fast track keys: Two programmable fast track keys are used to perform frequently used functions. These keys can easily be located by touch without taking your eyes off the part. Users can program either fast track key as described later in the **Hotkeys** portion of Chapter 2: Installation, Setup and Specifications.	

| Panel function key	Panel key
Numeric keypad: Used to enter numeric data. Additionally, the **decimal point key and +/- key** are used to adjust the contrast of the LCD display.	⑦ ⑧ ⑨ ④ ⑤ ⑥ ① ② ③ · ⓪ +/-
Send key: Used to transmit measurement results to a computer, USB printer or USB flash drive.	
LCD On/Off key: Press the LCD on/off button to turn the LCD display off without removing power from the ND 2100G. Press the button a second time to restore the LCD display. Additionally, the LCD On/Off key can be used to clear channel calibrations, delete data stored for a single part or delete data stored for all parts.	
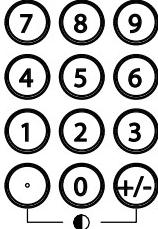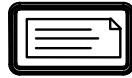
ND 2100G rear panel

1 Power switch
2 Power connection with fuse
3 Ground (protective ground)
4 Encoder inputs
5 Relay outputs
6 Parallel I/O port
7 RS-232-C interface
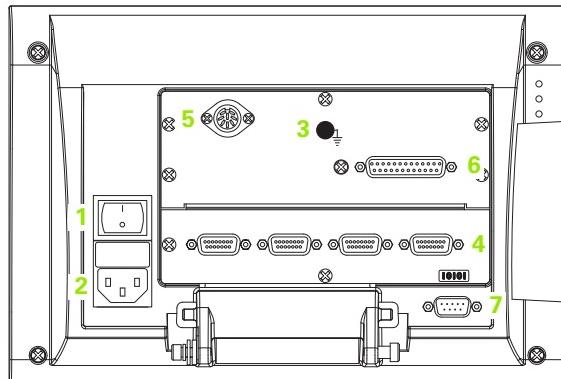
ND 2100G side panel

1 Speaker/headset jack
2 USB Type A connector
3 RJ-45 Foot switch/hand switch/keypad connector
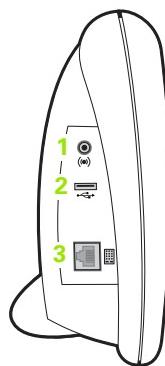
Information contained in this manual

This User's manual covers the operation, installation, setup and specifications of the ND 2100G. Operating information is contained in chapter 1. Installation, setup instructions and specifications are contained in chapter 2.

Fonts used in this manual

The following fonts are used to indicate operator controls or to show emphasis:

■ Operator controls - soft keys and other panel keys are shown in upper case

■ Emphasis - **Items of special interest** or **concepts** that are emphasized to the user are shown in bold type

Showing sequences of key presses

The ND 2100G user performs sequences of soft key and panel key presses to measure part features and complete other tasks. These sequences are indicated using text as shown in the following example:

■ Press the MENU... soft key, press the DATUM... soft key and then press the MASTER soft key is sometimes abbreviated as:

■ Press MENU/DATUM/MASTER

Symbols within notes

Notes are marked with symbols on the left indicating the type, or potential severity of the information.

General Information

This is additional or supplementary information about an activity or concept.

Warning

This warns of a situation or condition that could lead to measurement errors, equipment malfunction or equipment damage. Do not proceed until the message is read and understood.

Caution - Risk of electric shock

This warns of a situation or condition that could lead to electrical shock and to personal injury or death. Do not proceed until the message is read and understood.

Safety considerations

General accepted safety precautions must be followed when operating the system. Failure to observe these precautions could result in damage to the equipment, or injury to personnel. It is understood that safety rules within individual companies vary. If a conflict exists between the material contained in this manual and the rules of a company using this system, the more stringent rules should take precedence.

The ND 2100G is equipped with a **3-wire** power plug that includes a separate ground connection. Always connect the power plug to a 3-wire grounded outlet. Use of 2-wire power plug adapters or any other connection accessories that remove the third grounded connection create a safety hazard and should not be permitted.

Unplug the ND 2100G from the power outlet and seek the assistance of a qualified service technician if:

■ The power cord is frayed or damaged or the power plug is damaged

■ Liquid is spilled or splashed onto the enclosure

■ The ND 2100G has been dropped or the exterior has been damaged

■ The ND 2100G exhibits degraded performance or indicates a need for service some other way

ND 2100G channel inputs

The ND 2100G can be connected to the following channel configurations.

■ 1, 4, or 8 single input channels

■ Up to 16 networked RS-232 input channels

■ Or combinations of single input channels and networked RS-232 input channels for a total of up to 16 channels

Software version

The software version is shown in the About setup screen discussed later in chapter 2.

Cleaning

Use only a cloth dampened with water and a mild detergent for cleaning the exterior surfaces. Never use abrasive cleaners, and never use strong detergents or solvents. Only dampen the cloth, do not use a cleaning cloth that is dripping wet.

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Operation

1.1 ND 2100G Overview

Overview

The ND 2100G is an advanced digital readout system for performing single or multiple gage measurements at very high levels of precision and accuracy. Dimensional inspections of components are performed using encoders or transducers as part of in-line production activities, or final quality inspection. Measurements are conducted under operator control, or are semi-automated and conducted in conjunction with a fixtured gage system.

The ND 2100G is configured at the factory to support

- One, four or eight single-input channels, or
- Up to 16 multiplexed RS-232 input channels, or
- Combinations of single-input channels and multiplexed RS-232 input channels for a total of up to 16 channels

Channel inputs can be algebraically combined or processed by powerful math and control formulas to display dimensions such as flatness, volume and runout. Formulas are created as part of the ND 2100G setup using straightforward screen control and math functions.

C1=28.846 mm   Sum=C1+C2   Sum=12.820
C2=-16.026 mm   Dif=C1-C2   Dif=44.872
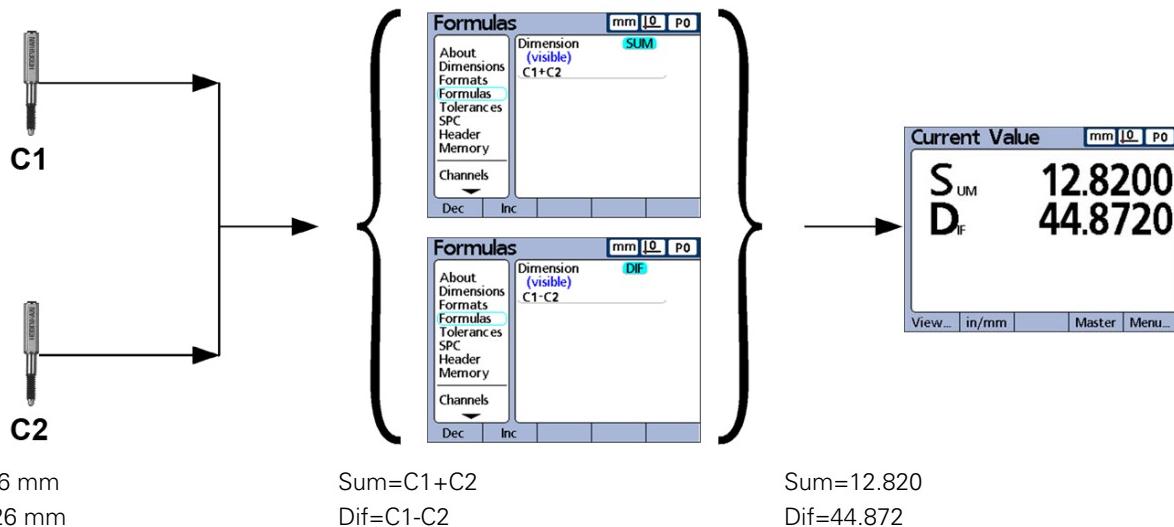
Channel inputs are processed by formulas to display dimensions.

The intuitive user interface includes a large character color LCD for fast and accurate measurement feedback. User interface screens include a digital readout of current values, bar and dial position value indicators, graphs of values, histograms of measurement statistics and tables of measurement and of SPC data.
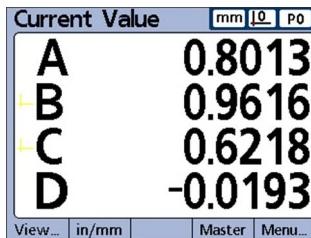
Digital readout (DRO)
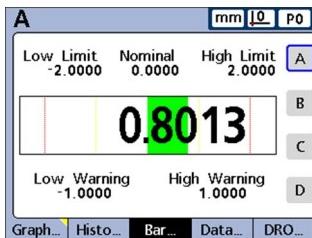
Horizontal bar
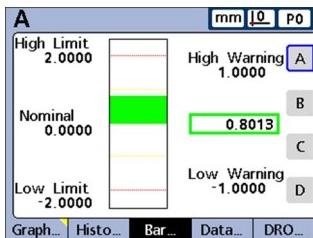
Vertical bar
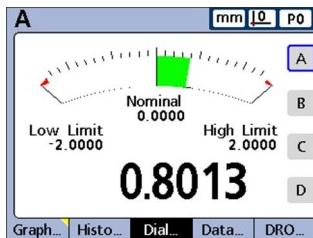
Dial
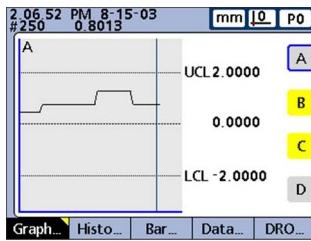
Graph of values
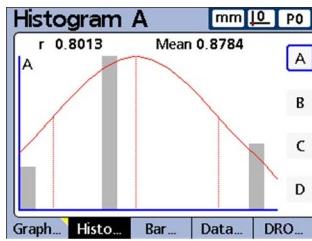
Histogram of values
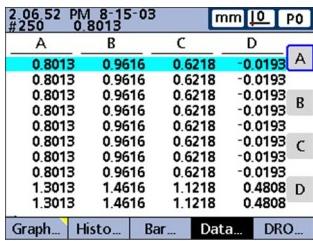
Measurement data

SPC data

1.2 Basic operation of the ND 2100G

Switching on the ND 2100G

Switch on the ND 2100G. The POWER switch is located on the rear of the enclosure. After switching the power on, or after a power failure, the power-up screen will be displayed.

finish

Press the FINISH key to advance from the power-up screen to the home screen.

Your ND 2100G is now ready for operation.

ND 2100G

Power-up screen.

Switching off the ND 2100G

Switch the ND 2100G off. The parts, formulas and dimensions that have been saved during operation will be retained in memory.

1.3 Panel key descriptions

Descriptions of panel key functions are provided in the following pages for Command, Fast Track, Send, LCD On/Off and Arrow Cursor keys. Soft key functions are also described later as part of LCD screens and menus.

ND 2100G Panel keys.

Command keys	Function
enter	**Enter data:** Press the ENTER key to enter data for a measurement. Information on the LCD is stored as measurement or configuration data. This information includes current dimension values or alphanumeric data for a configuration or user prompt data field.
finish	**Exit a screen:** Press the FINISH key to exit a screen saving any changes that were made. The FINISH key may also be used to return from the display of measurement or SPC data to the current home screen.
cancel	**Delete data or features:** Press the CANCEL key to erase the last data value entered into the system from the numeric keypad or delete data in configuration fields.
quit	**Quit current activity:** Press the QUIT key to abort the current task and return to the home screen or to exit the current menu.

Fast Track keys	Function
	Left frequently used function: Press the LEFT WIDE key to initiate the function programmed for this key. The factory default function for this key is RSETDYN.
	Right frequently used function: Press the RIGHT WIDE key to initiate the function programmed for this key. The factory default function for this key is ENTER.
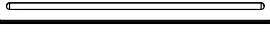
Send key	Function
	Transmit measurement results: Press the SEND key to transmit measurement data to a computer, a USB printer or a USB memory drive.

LCD On/Off key	Function
	Turn the LCD off or clear data: Press the LCD ON/OFF key to toggle between LCD on and LCD off, or to clear channel calibrations, delete data stored for a single part or delete data stored for all parts

Arrow cursor keys	Function
	Navigate menus and setup screen data fields.

Numeric keys	Function
	The numeric keypad is used primarily for numeric data entry. The decimal point key and +/- key can also be used to increase or decrease the LCD screen contrast when a decimal point or +/- input are not expected by the system as part of a data entry process. The screen contrast setting will be saved when the system is powered down and used as the default contrast setting the next time the system is turned on.

Dimension keys

Dimension keys can be assigned one of six hot key functions for use when the DRO screen is displayed. When graph, bar value and data screens are displayed, the dimension keys are used to display values for single dimensions or a smaller group of dimensions.

Dimension keys	Function
	Pressing a dimension key in the:
	■ **DRO screen:** performs the function assigned in the hotkey setup screen. By default no hotkey function is assigned until the user makes the assignment
	■ **Graph screens:** displays a single graph for the corresponding dimension
	■ **Bar screens:** Displays a single bar showing current values for the corresponding dimension
	■ **Data screens:** displays a single data table of stored values for the corresponding dimension

Soft keys	Function
	Soft keys initiate functions that are labeled above the keys at the bottom of the LCD screen. As different system functions are selected, the soft key labels change in support of those functions.

Pressing the dimension A key in a graph screen selects the A graph for display.

Pressing the VIEW... soft key changes soft key labels to show five screen viewing options, graph, histogram, bar, data and DRO.
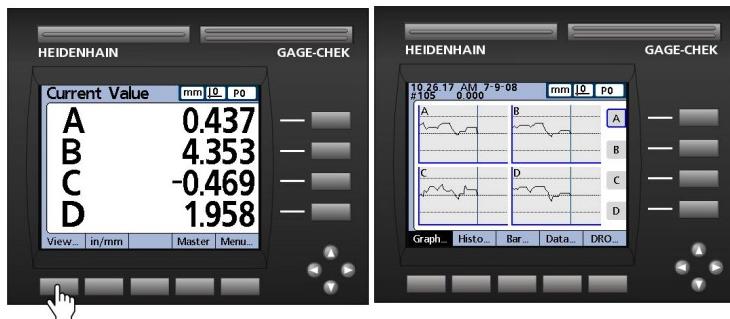
Pressing the VIEW... soft key causes soft key labels to change, offering five options for viewing data.

When viewing graphs of stored data, current value bars or tables of stored data, pressing a different soft key changes to the view indicated by the soft key label.
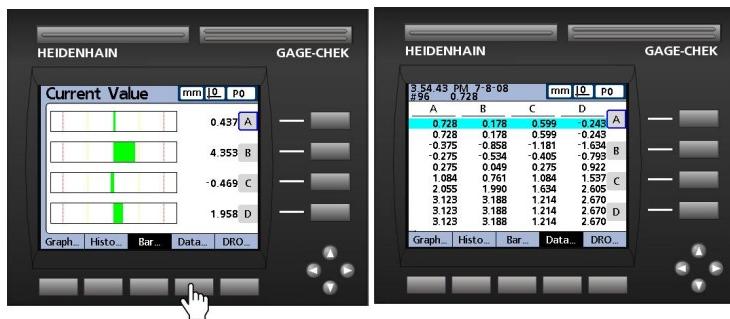
Pressing the DATA... soft key when viewing bars causes the dimension data table to be displayed.

Pressing the currently highlighted soft key alternates between single-dimension and multiple-dimensions displays.
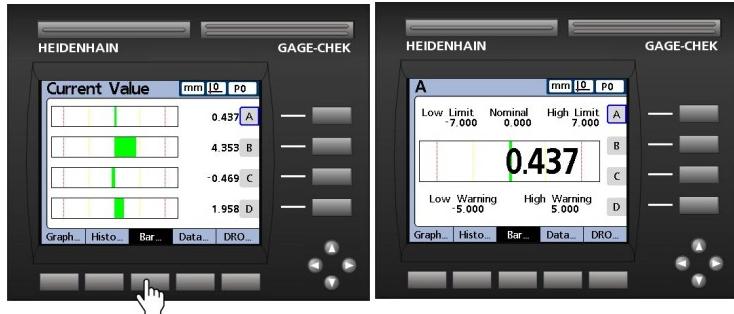
Pressing the BAR... soft key when viewing multiple-dimensions causes the currently selected dimension to be displayed by itself.

The left most soft keys can be designated hotkeys to provide quick access to commonly used functions when the home screen is displayed. Hot key assignments are discussed in detail in Chapter 2: Installation, Setup and Specifications.

1.4 LCD screens and menus

The ND 2100G LCD presents a variety of screens and menus selected by the user to display current dimension values, pass fail test results, dimension value graphs, statistical process control graphs and data tables, and setup and part configuration options.

Screen navigation

ND 2100G screen navigation is straightforward. For example, to display a bar graph of current values from the home screen, press the MENU... soft key, then press the VIEW... soft key and then the BAR... soft key.
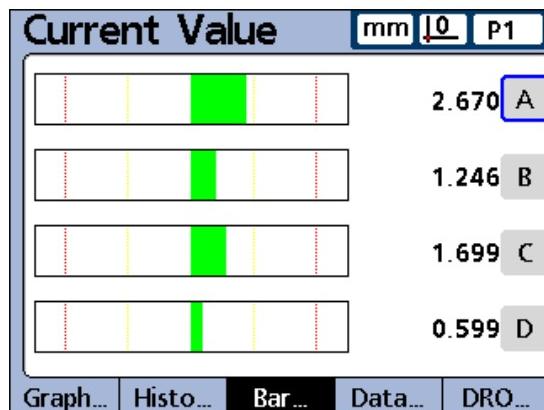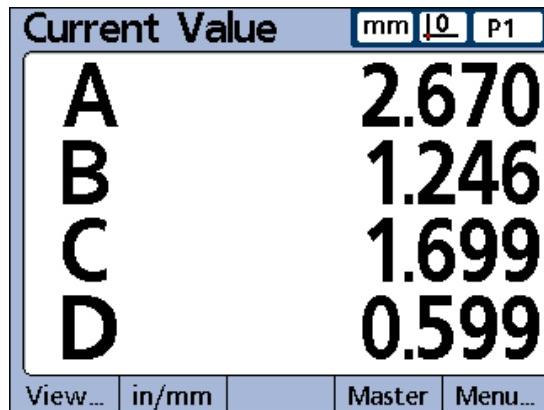
Press the VIEW... soft key then the BAR... soft key.

Home screen

The home screen is displayed after the startup screen when power is applied to the ND 2100G, and is displayed after the FINISH key is pressed to complete a measurement or screen evaluation.The default home screen is the DRO, but can be reassigned to another screen in the Display setup screen.

> The assignment of the home screen is discussed in detail in Chapter 2: Installation, Setup and Specifications.

DRO screen

The DRO screen is the default home screen displayed after power is applied and the startup screen is shown.The DRO screen provides numeric displays of the current values of up to four dimensions. The unit of measure, current datum and current part number or part name are displayed in the upper right corner of the screen.

Use the arrow cursor keys to scroll dimensions when more than four dimensions are active.

Current Value	mm 10 P0
A	0.437
B	4.353
C	-0.469
D	1.958
View...	in/mm	Datum...	Extra	Setup
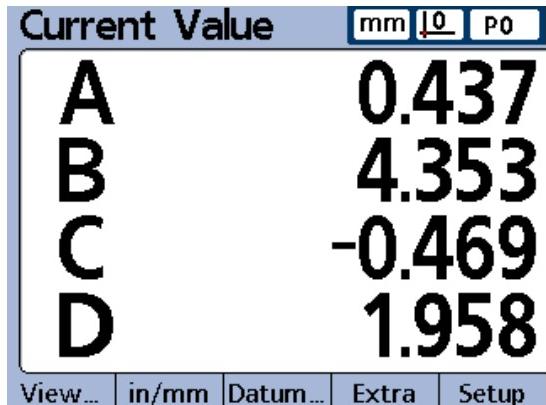
DRO screen

View soft keys and screens

View soft keys for subgroups of one

Pressing the VIEW... soft key when using subgroups of one, changes soft key labels to show five screen viewing options. Graph, histogram, bar, data and DRO.

Graph...	Histo...	Bar...	Data...	DRO...

View soft keys for subgroups of one.

View soft keys	Function
GRAPH...	Displays data in a line graph
HISTO...	Displays data in a histogram
BAR...	Displays data in a bar graph
DATA...	Displays numerical data
DRO...	Displays the DRO screen

Dimension graphs for SPC subgroups of one

The dimension graph screen is displayed for SPC subgroups of 1, and displays graphs for up to 16 dimensions.

Press the GRAPH... soft key to change the number of graphs presented on the screen. Press a dimension soft key to display a graph of the dimension and the minimum additional dimensions. Use the arrow cursor keys to scroll the graphs when more data is stored than will fit on the screen.

Individual samples are selected by a vertical line on the graph. Move the vertical line left and right through the stored data using the arrow cursor keys. The time and date that the selected sample was stored are shown in the upper left corner of the screen. The ID number of the sample for the dimension and the value of the data are also shown in the upper left corner. Displays of a single dimension also show the nominal and control limit values.

Vertical selection lines.
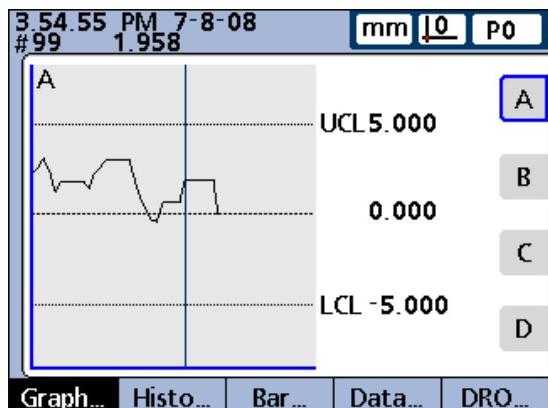
Dimension line graphs for subgroups of one.

Dimension histograms for SPC subgroups of one

The dimension histogram screen displays histograms of values for up to 16 dimensions. The dimension histogram screens are displayed for SPC subgroups of one.

Press the HISTO... soft key to change the number of histograms presented on the screen. Press a dimension soft key to display the histogram of a single dimension.

The display of a single dimension also shows the total range and mean of the values.
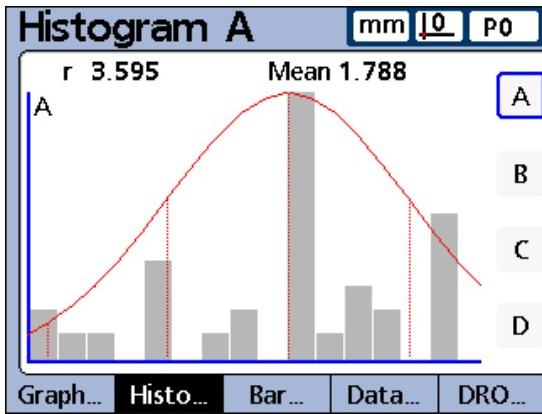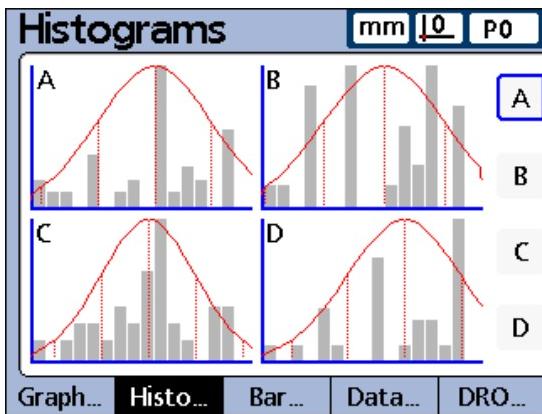
Dimension histograms for subgroups of one.

Bar and dial current value displays

The bar and dial screens provide graphic displays of the current values of up to 16 dimensions. The default bar screen can be configured to display current value bars in horizontal or vertical orientation using the Display setup screen.

Bar displays of multiple dimensions show current values. Bar displays of single dimensions include the current value, nominal value, and high and low warning and limit values.

Press the BAR... soft key to change the number of bars presented on the screen. Press a dimension soft key to display a bar for a single dimension.

The display can be configured in the Display setup screen to include a dial in addition to the bars. When the dial display is also available, press the BAR... soft key to toggle between the bars and the dial.

➡️ The display of a single dimension can be configured to be a bar or a dial, but cannot be toggled between a single bar and a single dial.
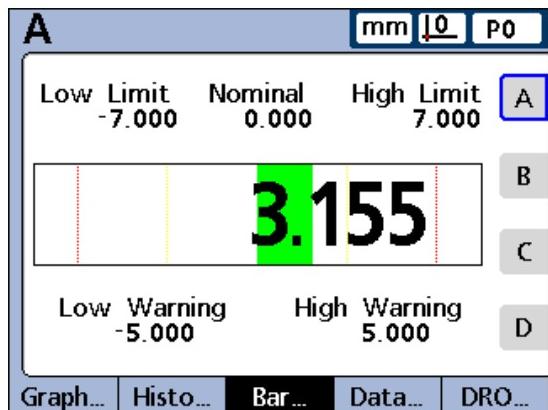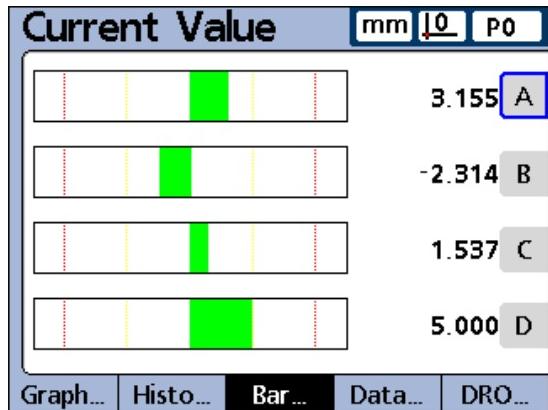
Bar graphs for subgroups of one.

Dimension data tables for SPC subgroups of one

Dimension data screens contain measurement data stored for up to 4 dimensions. Press the DATA... soft key to toggle between views of data for all dimensions and data for a single dimension that includes SPC statistics.

Press a dimension soft key to display data for a single dimension. Use the arrow cursor keys to scroll the tables when more data is stored than will fit on the screen.

| 3.54.55 PM 7-8-08 | | | mm | 0 | P0 |

| #99 | 1.958 | | | | |

A	B	C	D	
1.958	0.858	1.634	0.728	A
1.958	0.858	1.634	0.728	
0.728	0.178	2.994	-0.243	B
0.728	0.178	0.599	-0.243	
0.728	0.178	0.599	-0.243	
0.728	0.178	0.599	-0.243	C
-0.375	-0.858	-1.181	-1.634	
-0.275	-0.534	-0.405	-0.793	
0.275	0.049	0.275	0.922	D
1.084	0.761	1.084	1.537	

| Graph... | Histo... | Bar... | **Data...** | DRO... |

| 3.54.55 PM 7-8-08 | | mm | 0 | P0 |

| #99 | 1.958 | | | |

A		
1.958		A
1.958	Mean 1.788	
0.728	Max 3.220	
0.728	Min -0.375	B
0.728	r 3.595	
0.728	σ(p) 1.010	C
-0.375	6 σ 6.061	
-0.275	Pp 2.3100	
0.275	Ppk 1.7200	D
1.084		

| Graph... | Histo... | Bar... | **Data...** | DRO... |

Dimension data tables for subgroups of one.

View soft keys for subgroups greater than one

Pressing the VIEW... soft key, when using subgroups greater than one, changes soft key labels to show five screen viewing options. x̄, r, Bar, Data and DRO.

View soft keys	Function
x̄...	Displays the mean (x̄) of each subgroup for up to 16 dimensions
r...	Displays the range (r) of each subgroup for up to 16 dimensions
BAR...	Displays data in a bar graph
DATA...	Displays numerical data
DRO...	Displays the DRO screen

VIEW soft keys for subgroups greater than one.

Dimension x̄ charts for subgroups greater than one

For SPC subgroups greater than 1, the dimension x̄ screen is displayed in place of the dimension graph screen discussed earlier. The dimension x̄ screen graphs the mean (x̄) of each subgroup for up to 16 dimensions.

Press the x̄... soft key to change the number of graphs presented on the screen. Press a dimension soft key to display a graph of a single dimension.

Use the arrow cursor keys to scroll the graphs when more data is stored than will fit on the screen.

Individual subgroups are selected by a vertical line on the graph. Move the vertical line left and right through the stored data using the arrow cursor keys. The time and date when the selected subgroup data was stored are shown in the upper left corner of the screen. The ID number of the subgroup and the value of the data for the dimension are also shown in the upper left corner. Displays of single dimensions also show the control limits.
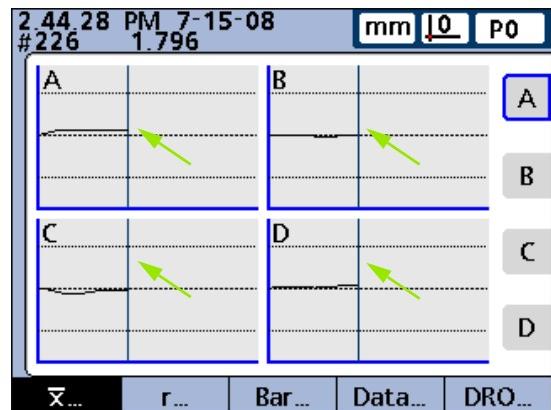
Vertical line.
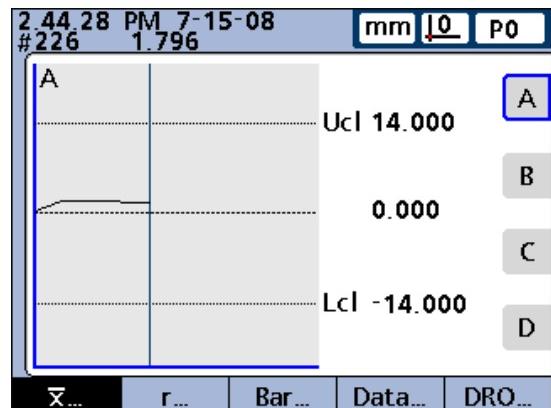
x̄ charts for subgroups greater than one.

Dimension r charts for subgroups greater than one

For SPC subgroups greater than 1, the dimension r screen is displayed in place of the Histogram screen discussed earlier. The dimension r screen graphs the range (r) of each subgroup for up to 16 dimensions. The range is not recalculated for each measurement, but is recalculated each time a subgroup is completed. Refer to "SPC setup screen" on page 91.

Use the arrow cursor keys to scroll the graphs when more data is stored than will fit on the screen.

Individual subgroups are selected by a vertical line on the graph. Move the vertical line left and right through the stored data using the arrow cursor keys. The time and date when the selected subgroup data was stored are shown in the upper left corner of the screen. The ID number of the subgroup and the value of the data for the dimension are also shown in the upper left corner. Displays of single dimensions also show the range control limits.
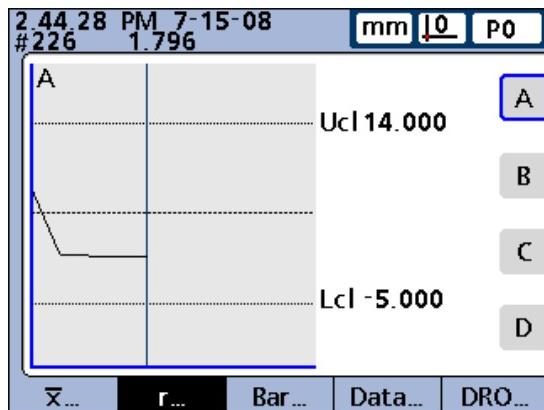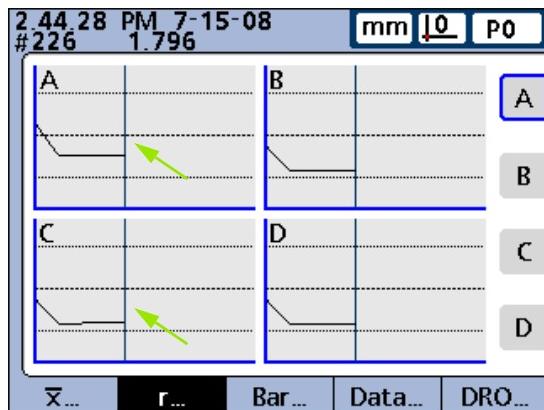
r charts for subgroups greater than one.

Dimension data tables for subgroups greater than one

Dimension data screens display measurement data for up to 4 dimensions. The Data screen for a single dimension is slightly different for SPC subgroups greater than 1 than those for SPC subgroups of 1. Individual subgroups are indicated by a horizontal line in tables for single dimensions. The data table for multiple dimensions remains unchanged for SPC subgroups greater than 1.

Press the DATA... soft key to toggle between views of data for all dimensions and data for a single dimension that includes SPC statistics. Press a dimension soft key to display data for a single dimension.

Use the arrow cursor keys to scroll the tables when more data is stored than will fit on the screen.

The time and date when the highlighted subgroup data was stored are shown in the upper left corner of the screen. The ID number of the data record and the value of the data for the dimension are also shown in the upper left corner.

2.44.28 PM 7-15-08 #226 1.796			mm	PO
A	B	C	D	
1.796	0.663	0.469	1.667	A
1.667	0.372	0.146	1.472	
1.893	0.178	0.340	1.278	B
1.893	0.016	-0.049	1.181	
2.217	-0.146	-0.469	0.825	
2.184	0.178	-0.728	1.019	C
1.990	0.502	-1.019	1.375	
2.152	0.663	-0.793	1.537	
-2.929	-2.994	-2.832	-2.832	D
3.900	3.867	3.803	3.867	
$\overline{x}$...	r...	Bar...	Data...	DRO...

2.44.28 PM 7-15-08 #226 1.796				mm	PO
A					
1.796 $\overline{x}$	1.731	$\overline{r}$	1.430		A
1.667 r	0.129	Mean	1.676		
1.893 $\overline{x}$	1.893	Max	3.900		B
1.893 r	0.000	Min	-2.929		
2.217 $\overline{x}$	2.201	r	6.828		
2.184 r	0.032	$\sigma(p)$	1.736		C
1.990 $\overline{x}$	2.071	6σ	10.418		
2.152 r	0.162				
-2.929 $\overline{x}$	0.485	Pp	1.3438		D
3.900 r	6.828	Ppk	1.0220		
$\overline{x}$...	r...	Bar...	Data...	DRO...	

Dimension data tables for subgroups greater than one.

in/mm menu items

Press the IN/MM soft key to toggle the display between inch and millimeter units of measure. This does not alter the channel configurations in the Channel setup screen. The ND 2100G calculates the conversion from one unit of measure to another as a convenience to the user.

Master menu items and screens

Master screens are used to calibrate the encoder datums or transducer input channel ranges. The Master function is configured in the Master setup screen to either calibrate datum D0 for encoders, or calibrate datum D0 and the entire channel range for transducers.

> Prior to applying, and after clearing a mastered channel value, the ND 2100G machine zero is used as the absolute datum.

Master screen for calibrating encoder datums

When the Master setup screen is configured to perform full calibrations of transducer input channels (Master type set to Min-Max), the full range of any channel input can be calibrated at any time using the Master function Min and Max screens. Up to 18 range calibration values can be stored for each ND 2100G transducer input channel. Any of these groups can be quickly recalled and applied later.

> Instructions for calibrating channel datums are provided later in this chapter.
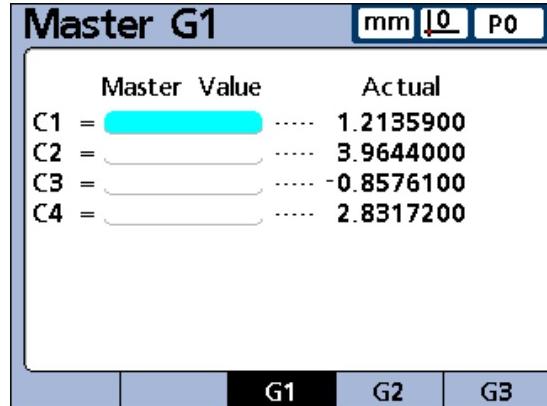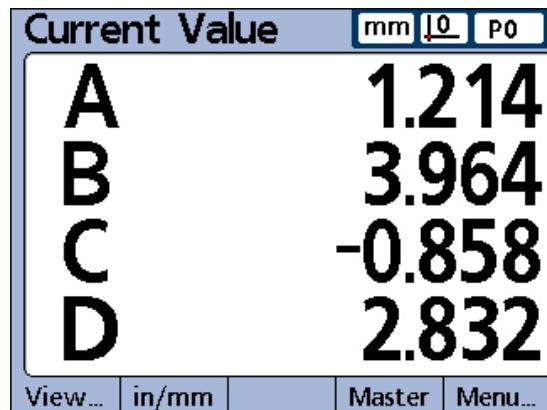
Pressing the MASTER soft key brings up the Channel Master screen for calibrating encoder datums.

Master screen for calibrating transducer ranges

When the Master setup screen is configured to perform full calibrations of transducer input channels (Master type set to Min-Max), the full range of any channel input can be calibrated at any time using the Master function Min and Max screens. Up to 18 range calibration values can be stored for each ND 2100G transducer input channel. Any of these groups can be quickly recalled and applied later.

➡ Instructions for calibrating transducer input channels Min and Max range values are provided later in this chapter.

Master Min screen for calibrating transducer range.

Master Max screen for calibrating transducer range.

Menu soft keys

Pressing the MENU... soft key changes soft key labels to show Menu options: View..., in/mm, Datum..., Extra and Setup.

Menu soft keys.

Menu soft keys	Function
VIEW...	Pressing the VIEW... soft key provides access to View menu options. Refer to "View soft keys and screens" on page 28.
IN/MM	Pressing IN/MM soft key toggles between inch and millimeter units of measure for applicable dimensions. Refer to "in/mm menu items" on page 35.
DATUM...	Pressing the DATUM... soft key provides access to Datum menu options.
EXTRA	Pressing the EXTRA soft key provides access to Extra menu options.
SETUP	Pressing the SETUP soft key provides access to Setup menu options.

The datum menu functions

The DATUM... functions provide the means to ZERO, PRESET, CLEAR and toggle between measurement reference datums.

| D0/D1 | Zero... | Master | Preset | Clear |

Datum soft keys.

Datum soft keys	Function
D0/D1	Pressing the D0/D1 soft key toggles between the absolute datum (D0) and the incremental datum (D1).
ZERO...	The Zero menu function can be used at any time to simultaneously zero all incremental datums, or to zero any specific incremental datum.
MASTER	The Master functions are used to calibrate the encoder datums or transducer input channel ranges.
PRESET	The Dimension Preset screen is used to preset incremental datums. The incremental datum of a dimension can be preset to a specific value at any time by pressing the PRESET soft key, pressing a dimension soft key and entering the desired value.
CLEAR	The Clear menu function can be used at any time to simultaneously clear all incremental datums. Cleared incremental datums (D1) are made equal to absolute datums (D0).

The Extra menu functions

The Extra menu provides quick access to a variety of display and other system functions. To use any Extra menu function, highlight the desired function, and then press the ENTER key.

Extra menu functions	Function
Cycle	Advances to the next defined part. Part numbers are cycled in a continuous loop.
DMS/DD	Toggles the display of angles between Degrees, Minutes, Seconds (DMS) and Decimal Degrees (DD).
Fast3	Refer to "Fast3" on page 39.
Hold	Toggle function that holds (freezes) or releases the current value of a single dimension when a dimension soft key is pressed, or of all dimensions when the ALL soft key is pressed.
Part?	Displays a pop-up screen that allows the user to specify a new part number.
Rad/Dia	Toggles between the radius and diameter measurement types on the DRO screen, if radius or diameter was specified in the Formats setup screen.
Recall	Applies the last used incremental datum (D1) preset that was entered by the user.
RsetDyn	Resets the minimum and maximum values accumulated during dynamic measurements. This function must be initiated prior to new dynamic measurements.
Send	Sends the specified current dimension values, or all current dimension values to the RS-232 serial port for transmission to a computer. The user is prompted to send one or all.
SendRec	Sends stored records to the RS-232 serial port for transmission to a computer. Refer to "Report setup screen" on page 127.
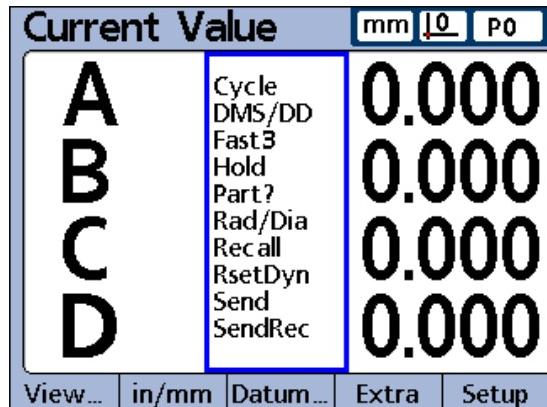
EXTRA menu functions.

Fast3

The Fast3 function samples the channel 2 input each time the channel 1 input changes a specified sample increment. If the sampled value of channel 2 falls outside a specified range, all base-channel (first 1, 4 or 8 channels) input values will be stored in a dedicated memory array, otherwise samples will not be stored.

This sampling process continues until:

■ The user aborts the process by pressing the QUIT or the CANCEL key

■ The user clears memory and restarts the process by pressing the ENTER key

■ The user successfully completes the process by pressing the FINISH key

■ The process is automatically completed after 50,000 sets of channel positions have been stored

> For the duration of the Fast3 function process, the ND 2100G adopts an X-Y axis paradigm. Channel 1 is referred to as the X-axis, and channel 2 as the Y-axis.
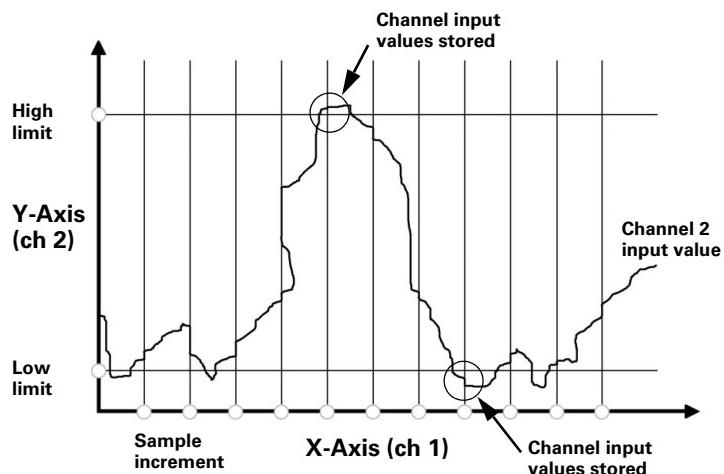
In the example shown, the channel 2 (Y-axis) input values exceed the user-specified limits five times, but channel input values are stored only twice when the channel 2 value exceeds the limits at a sample point between intervals.

When the Fast3 function is successfully completed, the stored sets of channel input values are processed by the ND 2100G dimension formulas in the order that they were collected. The formula results are then stored in the ND 2100G database. During the processing of formulas, a percentage of completion will be displayed. Since up to 50,000 sets of channel input values can be collected and processed by formulas, considerable time could be required to complete the processing.

> Since the values processed by formulas after Fast3 data collection are contained in memory storage, no user interaction is possible. For this reason functions that require user interaction such as the Ask function must be avoided in formulas when the Fast3 Extra menu function is used.

> If any key is pressed while the ND 2100G is processing formulas, the remaining channel input values will be deleted from memory and formula processing will be aborted.

To access the Fast3 function:

▶ Press the MENU... soft key
▶ Press the EXTRA soft key
▶ Use the arrow cursor keys to highlight Fast3
▶ Press the ENTER key

You will then be prompted to:

▶ Enter a Y axis (channel 2) upper limit
▶ Enter a Y axis (channel 2) lower limit
▶ Enter an X axis (channel 1) capture increment
▶ Enter an X axis (channel 1) resolution factor (this is a multiplier of scale resolution)

Once these parameters are entered, the Fast3 function will begin to read the input values for channels 1 and 2.

Setup menu functions

ND 2100G operating parameters and formulas that define dimension values are entered into the system from Setup menu screens.

> Setup menu functions and formulas and are discussed in Chapter 2: Installation, Setup and Specifications
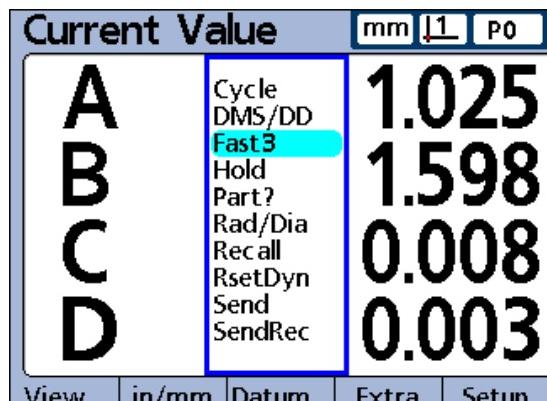
FAST3 highlighted.

1.5 Operating instructions

Basic operation of the ND 2100G is illustrated by the typical process steps below.
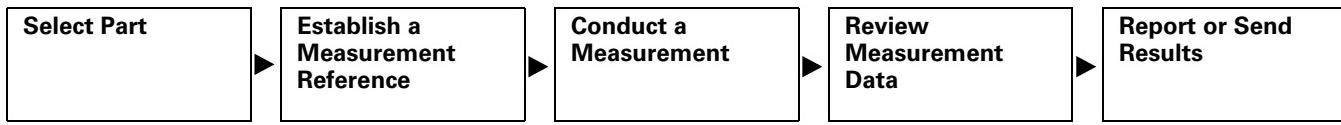
Select Part		Establish a Measurement Reference		Conduct a Measurement		Review Measurement Data		Report or Send Results
Specify part number		Absolute datum (D0)		Manual:		SPC Subgroup = 1		Print reports
		• Hard stop zero		• Probe & Enter		• Dimension graphs		Send data to computer
		• Set datum		Sequence:		Histograms		
		• Calibrate datum and range		• Series of probes & Enters		• Dimension data tables		
		Incremental datum (D1)		Dynamic:		• SPC data		
		• Zero datum		• Probe samples & Enter		SPC Subgroups > 1		
		• Preset datum		Semi-automated:		• $\bar{x}$ graphs		
				• Probe & automatic Enter		• r graphs		
						• Dimension data tables		
						• SPC data		

Measurement steps and the resulting data collected depend entirely on setup parameters and dimension formulas defined to satisfy a specific application.

➡ Examples used in this chapter use encoder probes to emphasize concepts. However, the concepts apply equally well to all types of input devices.

Select a part to begin a measurement

The correct part (number) must be selected prior to conducting measurements.

Select Part		Establish a Measurement Reference		Conduct a Measurement		Review Measurement Data		Report or Send Results
	▶		▶		▶		▶	
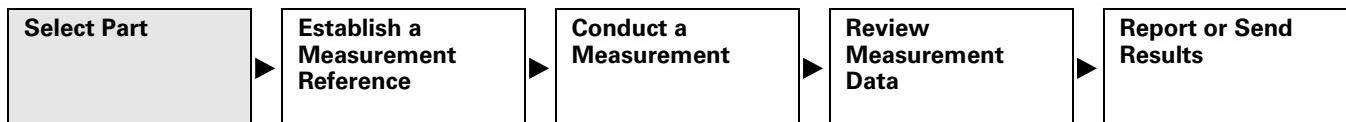
One hundred part configurations can be stored in the ND 2100G. Each part configuration includes all the ND 2100G settings and dimension formulas required to conduct measurements and report results for the part.

To select a part:

▶ Press the MENU... soft key

▶ Press the EXTRA soft key

▶ Use the arrow cursor keys to highlight Cycle or Part?

▶ Press the ENTER key. If Part? was highlighted, you will be prompted for a part number.

▶ Use the numeric keypad to specify the part

▶ Press the ENTER key

If Cycle was highlighted, the part number will be incremented. Continue incrementing to select the desired part number.
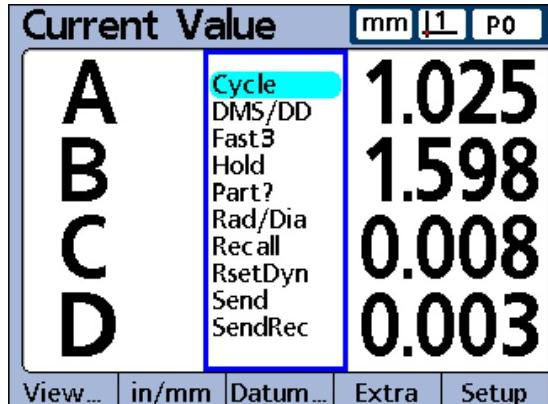
Cycle highlighted.
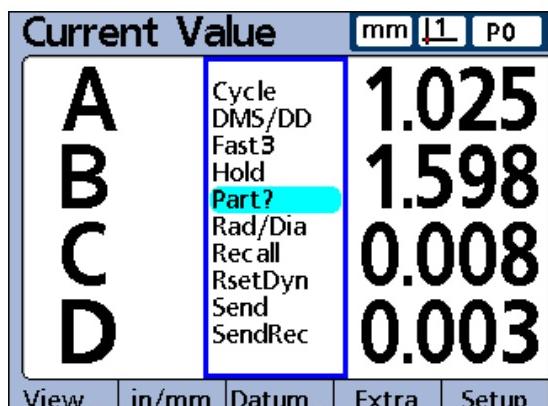
Part? highlighted.

Establish a reference for the measurement

A measurement reference should be established prior to conducting measurements. Measurement references can be established by calibrating channels or presetting dimensions.

Select Part		Establish a Measurement Reference		Conduct a Measurement		Review Measurement Data		Report or Send Results
	▶		▶		▶		▶	
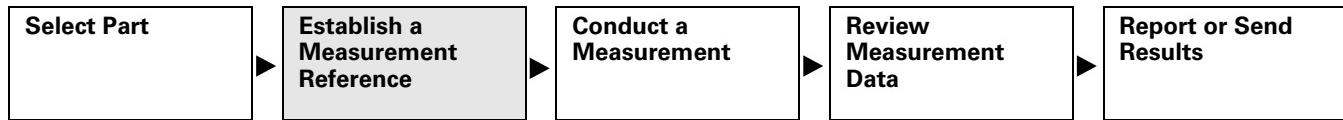
> An input calibration is applied to any parts that use that channel in a formula. For example, a channel calibration performed for channel 1 and part number 0 will also apply to any other parts using channel 1.

Calibrating channels using the Master function

Channel calibrations are performed using the Master function. A single-point calibration defines the reference value of the absolute datum (D0) of an input channel. A full calibration defines the reference value of the absolute datum, and the resolution of the channel input.

Since encoders have fixed resolutions based on etched scales or some other permanent device characteristic, typically only a single point is calibrated to define a reference position. Transducers such as LVDT and Half-bridge devices do not have fixed resolutions. The use of these devices requires calibrating both ends of the transducer's measurement range to derive resolution. Once a full calibration has been performed, single-point calibrations can be performed as required to define new measurement reference positions.

Calibration of a single reference point

A single measurement reference point can be calibrated for encoders and fully-calibrated transducers.

➡ The Master type should be set to Mean in the Master setup screen to perform a calibration of a single encoder point. Refer to "Master setup screen" on page 111.

To calibrate a single reference point

▶ Press the MASTER soft key

▶ Use the arrow cursor keys to select the desired channel

▶ Position the probe against the reference surface

▶ Use the numeric keypad to enter the reference value (zero or the desired offset) into the Master Value data field

▶ Press the ENTER key

▶ Press the YES soft key to calibrate the measurement reference

A green dot will appear next to the actual value indicating that the reference point is calibrated.

Channel 1 selected. Reference value of 0.

Press the YES soft key.

Channel 1 calibrated.

Calibration groups (G1, G2, G3...G18)

All calibration values shown on the screen are simultaneously applied when the ENTER key is pressed. While this is acceptable in most cases, some applications require entering a series of calibrations at different times. The example shown here illustrates this difference.

When measuring runout at two points on a rod, both channels are measuring a common surface and can be calibrated simultaneously. In this example, both channels are calibrated to zero on the rod surface in calibration group 1 (G1). Completed calibrations are indicated by filled circles at the right of the actual channel values.

Calibrating two points on a rod.

When measuring the low and high lifts of two offset cams, simultaneous calibration on the offset surfaces is not possible. First one channel must be calibrated to zero on the low surface of one cam, then after turning the cam shaft 90 degrees, the second channel must be calibrated to zero on the low surface of the second cam.

The first calibration is performed in calibration group 1 (G1), then the camshaft is turned 90 degrees, and the second calibration is performed in calibration group 2 (G2). By performing the calibrations in different groups, the calibrations are made independent. Completed calibrations are indicated by filled circles at the right of the actual channel values.

Calibrating offset surfaces Master G1.

Calibrating offset surfaces Master G2.

Calibrations of transducer resolution (Min-Max calibrations)

Transducers such as LVDT and half bridge devices do not have fixed resolutions based on etched scales or other permanent device characteristics. The use of these devices requires calibrating both ends of the transducer range of measurement to derive transducer resolution. Full transducer calibrations are performed periodically on a schedule determined by your application using the Master function. Full calibrations are performed only after performing the transducer gain and null setup steps described in Chapter 2: Installation, Setup and Specifications.

> The Master type should be set to Min-Max in the Master setup screen to perform a full transducer calibration. Refer to "Master setup screen" on page 111.

To perform a full transducer calibration:

Calibrate minimum level:

▶ Press the MASTER soft key
▶ Press the MIN soft key to display the Master Min screen
▶ Use the arrow cursor keys to select the desired channel
▶ Press the G1, G2...G18 soft key to select a group to store the calibration data in. Refer to "Calibration groups (G1, G2, G3...G18)" on page 45.
▶ Position the channel's probe against the measurement Min reference surface
▶ Use the numeric keypad to enter the Min reference value into the Master Value data field for the channel
▶ Press the ENTER key
▶ Press the YES soft key to set the Min value or offset the absolute datum (D0) for the channel. This calibrates the low end of the channel measurement range.

The completed minimum level calibration will be indicated by a filled green circle in the Mn column at the right of the Actual channel value.

Completed minimum level calibration.

Calibrate maximum level:

▶ Press the MAX soft key

▶ Use the arrow cursor keys to select the same channel as in step 1 if necessary

▶ Position the channel probe against the measurement Max reference surface for the maximum end of the channel calibration range

▶ Use the numeric keypad to enter the Max value into the Master Value data field for the channel

▶ Press the ENTER key

▶ Press the YES soft key to calibrate the maximum value for the channel input

The completed maximum level calibration will be indicated by a filled green circle in the Mx column at the right of the Actual channel value.

Completed maximum level calibration.

Establishing a temporary dimension reference

Establishing a temporary dimension reference is useful when quick point to point measurements are desired. The temporary reference is only applied to the associated dimension, and only to the current part. For example, a temporary reference established for dimension A and part number 0 will not apply to any dimensions or to any other parts that might include their own dimension A.

Temporary dimension references can be established for encoders and transducers. Since only one point is used as a reference, transducer resolution remains unchanged.

Dimension references can be zeroed or preset to specific values.

Zeroing a dimension reference

Dimensions can be zeroed at any time using the Datum/Zero function. The zero reference is temporary in the sense that it uses the incremental datum D1, and has no effect on the absolute datum D0.

To zero a dimension:

▶ Press the MENU... soft key
▶ Press the DATUM soft key
▶ Press the ZERO... soft key. The soft keys across the bottom of the screen will be labeled to support zeroing specific or all dimensions.
▶ Use the left and right arrow cursor keys to scroll through dimensions when there are more dimensions defined than ND 2100G soft keys
▶ Press the desired ZERO key to zero the corresponding dimension
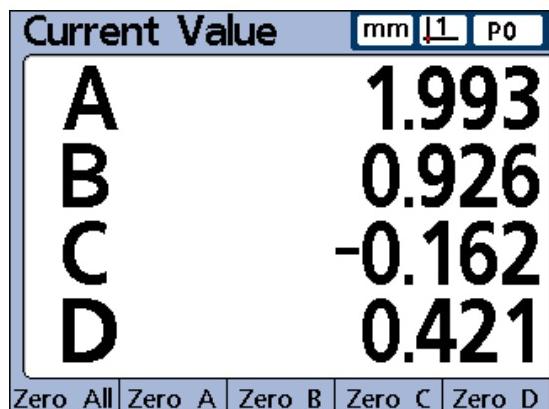
Dimension A prior to zeroing.
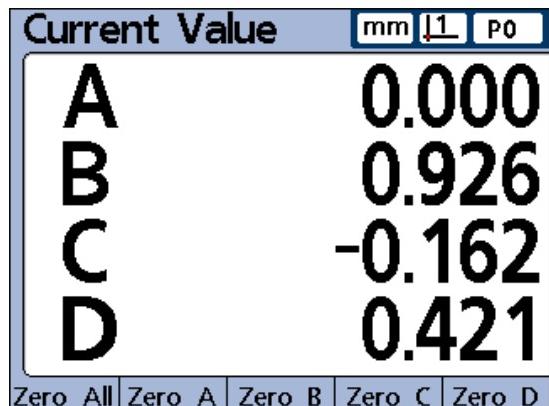
Dimension A zeroed.

Presetting a dimension reference to a specific value

Dimensions can be preset to a user-specified value using the Datum/Preset function. The reference is temporary in the sense that it uses the incremental datum D1, and has no effect on the absolute datum D0.

To preset a dimension reference:

▶ Press the MENU... soft key

▶ Press the DATUM soft key

▶ Press the PRESET soft key. The Select dimensions screen will be displayed.

▶ Press the dimension key associated with the dimension you wish to preset. A text line will be displayed

▶ Use the numeric keypad to enter the reference value (preset) of the new reference

▶ If desired, press the W/NOM soft key to change the nominal value in the Tolerance setup screen to the new preset reference value

▶ Press the ENTER key to preset the dimension measurement reference
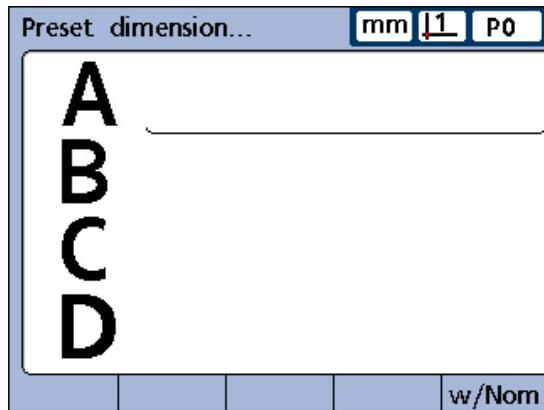
Dimension preset text line.
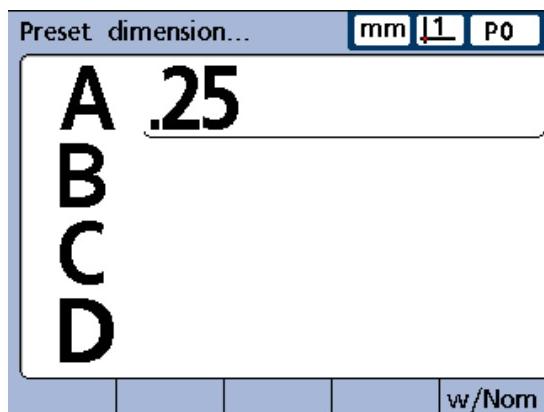
Enter the reference value.
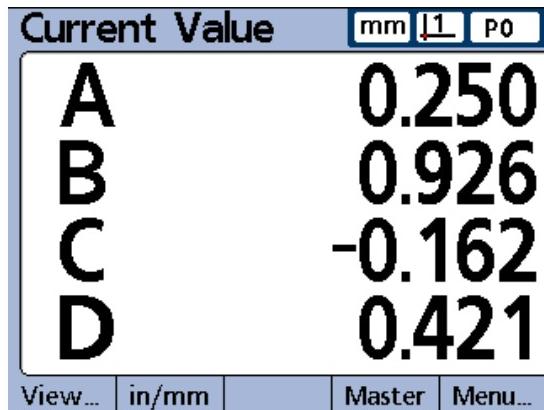
Dimension A preset.

Clearing channel calibrations

The reference calibrations and full calibrations of all channels can be cleared using the LCD ON/OFF key.

To clear calibrations:

▶ Press the LCD ON/OFF key

▶ Press the CLR CAL soft key

▶ Press the YES soft key to clear channel mastered values and full calibrations

Channel mastered values and full calibrations will be cleared, indicated by the empty circles at the right of the screen. The values will be retained in the Master values fields, and can be reactivated at any time by pressing the ENTER key.
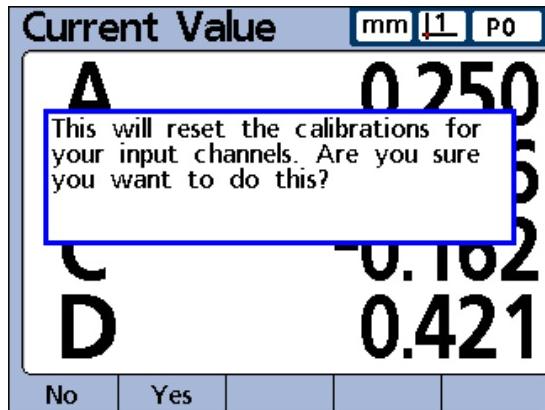
Press the YES soft key to confirm clearing channel calibrations.
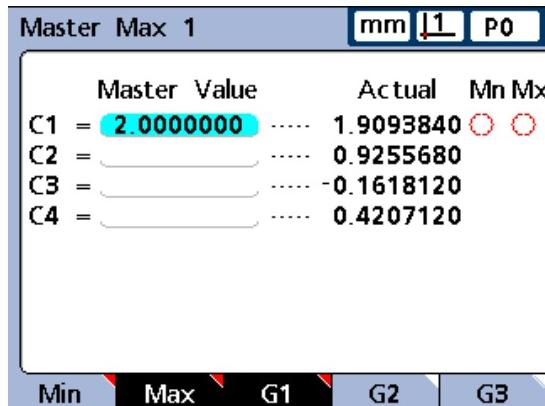
Empty circles indicate channel mastered values and full calibrations are cleared.

Clearing dimension references (presets)

Dimension references can be cleared at any time using the Datum/Clear function.

To clear dimension references:

▶ Press the MENU... soft key

▶ Press the DATUM soft key

▶ Press the CLEAR soft key

▶ Press the YES soft key to clear dimension preset references. When a preset reference is cleared, D0 becomes the new reference.
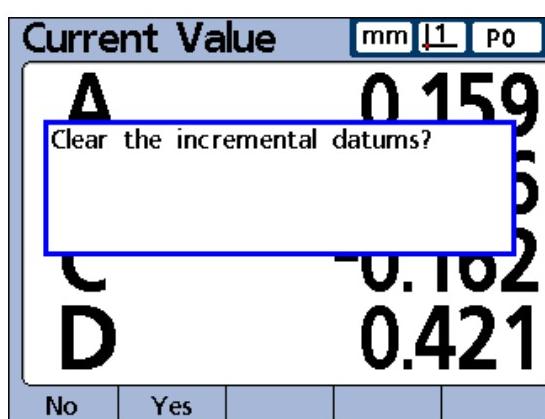
Press the YES soft key to confirm clearing dimension references.

Conducting measurements

Once a part number is selected and a reference is established, measurements can be conducted.

Select Part		Establish a Measurement Reference		Conduct a Measurement		Review Measurement Data		Report or Send Results
	▶		▶		▶		▶	
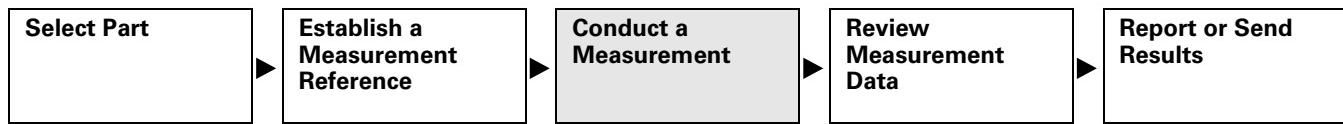
Measurements can:

- Be conducted manually, completely under the control of the operator

- Follow a predetermined sequence of steps shown on the screen

- Be based on dynamic samples of changing input data

- Be semi-automated to increase the throughput of repetitive measurements

Typically a setup person will configure the ND 2100G for operation in the Setup screens and then will construct formulas defining dimensions in the Formula screens described in Chapter 2: Installation, Setup and Specifications.

Once the ND 2100G is configured and dimension formulas are constructed, measurement instructions are usually given to the operator that reflect the specific measurement requirements and gage equipment setup. Instructions provided in this guide are generic and meant to be used as guidelines when applying the ND 2100G to specific measuring applications.

Manual measurements

Manual measurements are performed completely under the control of an operator. Measurement results can be displayed as current values, in graphs or in data tables using the screens described earlier in this chapter. Please refer to the descriptions of Views on page 28.

Measurements can also be printed or transmitted to a computer. The data printed or transmitted are specified and formatted in the setup screens described in Chapter 2: Installation, Setup and Specifications.

To conduct manual measurements:

▶ Probe a single point with one channel, or multiple points simultaneously with multiple channels

▶ When the measurement data are displayed on the LCD, press the ENTER key to store the data

Sequential measurements

The ND 2100G can be configured in the Formula setup screen to direct the user through a sequence of predetermined measurement steps. Typically a setup person will provide instructions describing how to conduct the measurements. However, the ND 2100G operation is fundamentally the same for all sequential measurements.

Measurement results can be displayed as current values, in graphs or in data tables using the screens described earlier in this chapter. Please refer to the descriptions of Views on page 28.

Measurements results can also be printed or transmitted to a computer. The data printed or transmitted are specified and formatted in the setup screens described in Chapter 2: Installation, Setup and Specifications.

To perform a sequential measurement:

▶ Probe the dimension underlined on the DRO screen

▶ Press the ENTER key to store the data. The underline will advance to highlight the next dimension in the measurement sequence.

▶ Continue probing the underlined dimensions and pressing the ENTER key, following the sequence of underlined steps on the LCD

When measurements specified for the part are complete, the ND 2100G will return to underline the first dimension in the series to indicate the beginning of a new sequence.
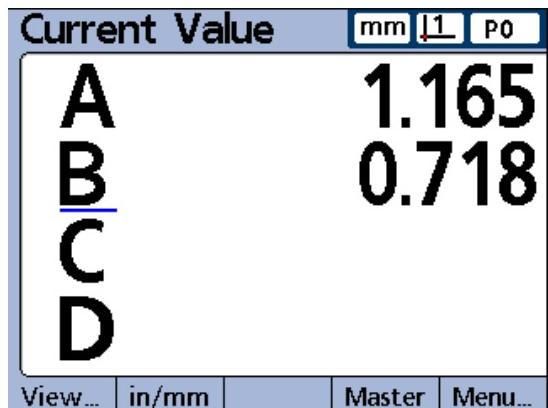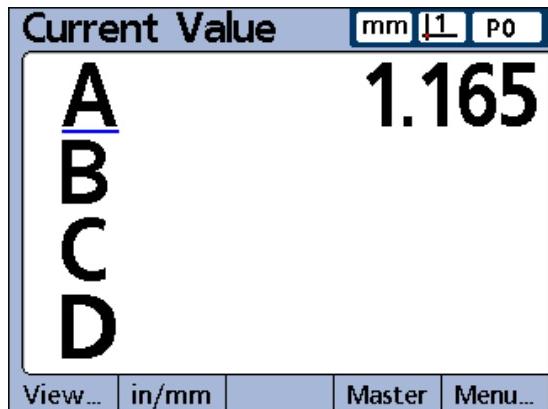
Press the ENTER key to store data and advance to next dimension.

Dynamically sampled measurements

The ND 2100G can be configured in the Formula setup screen to sample input channels and retain the minimum and maximum values of all samples for each channel. Typically a setup person specifies dynamic measurements to evaluate rotational or curved surfaces and will provide instructions describing how to conduct the measurements. The ND 2100G operation is essentially the same for all dynamic measurements.

Measurement results can be displayed as current values, in graphs or in data tables using the screens described earlier in this chapter. Please refer to the descriptions of Views on page 28.

Measurement results can also be printed or transmitted to a computer. The data printed or transmitted is specified and formatted in the setup screens described in Chapter 2: Installation, Setup and Specifications.

In the example shown here, the runout of a shaft is measured. The minimum and maximum values are sampled as the shaft is turned.

To perform a dynamic measurement:

▶ Perform a dynamic reset by pressing the LEFT WIDE key (factory default), or by highlighting RsetDyn in the Extra menu

▶ Press the ENTER key to clear old dynamic measurement data prior to a new measurement

▶ Position the probe(s) against the surface to be measured

▶ Rotate or move the surface slowly while observing the resulting dimension value(s)

⚠ The sampling rate for LVDT, HBT (Half-bridge) and serial transducers will be slower than for encoders. If your system includes these input devices, the part must be rotated or moved slowly to ensure that all points on the surface are sampled.

▶ Repeat the rotation or movement until the dimension values that reflect minimum or maximum values no longer change

▶ Press the ENTER key to store the measurement data
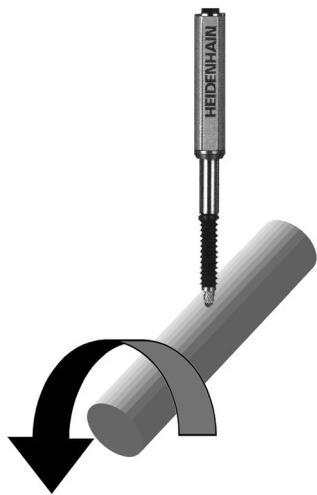
Measuring the runout of a shaft.

Semi-automated measurements

Normally, measurements shown on the DRO screen are not stored in the ND 2100G database until the user presses the ENTER key. However, the ND 2100G can be configured in the Formula setup screen to perform and store measurements automatically when the gage is loaded with a new part.

Measurement results can also be printed or transmitted to a computer. The data printed or transmitted is specified and formatted in the setup screens described in Chapter 2: Installation, Setup and Specifications.

In the example shown here, the flatness of a sheet is measured. The measurement is performed and entered into the database a short time after the gage is lowered to position the probes against the surface of the sheet. The channels are reset for a new measurement when the probes are lifted away from the sheet.

Typically, a setup person specifies semi-automated measurements to increase the throughput of repetitive measurements, and will provide instructions describing how to conduct the measurements, and load and unload the gage.

Measurement results can be displayed as current values, in graphs or in data tables using the screens described earlier in this chapter. Please refer to the descriptions of Views on page 28.

The instructions for performing semi-automated measurements depend entirely on the measurement application and equipment setup, and must be provided by the setup person. Refer to "Trip function and measurement automation" on page 212 for more details regarding semi-automated measurements.
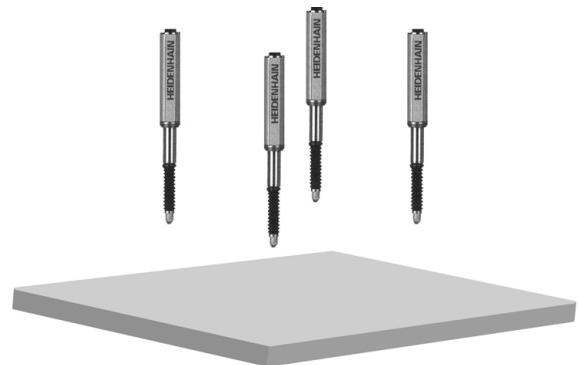
Load part: Channels ready
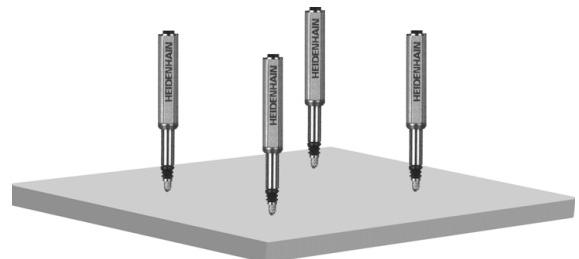
Gage closed: Channels measure
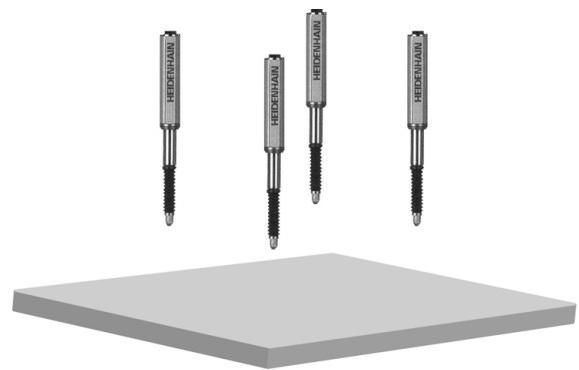
Unload part: Channels reset

Reviewing measurements

Measurement results can be reviewed in graphs or in data tables using the screens described earlier in this chapter. Please refer to the descriptions of Views on page 28.

Select Part	▶	Establish a Measurement Reference	▶	Conduct a Measurement	▶	Review Measurement Data	▶	Report or Send Results
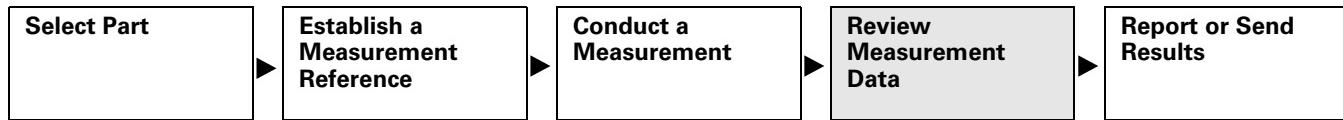
Printing reports or sending results to a computer

Measurement data can be printed or transmitted to a computer. The report and data transmission formats are prepared in the Header, Report, Send, Parallel and RS-232 setup screens described in Chapter 2: Installation, Setup and Specifications.

Select Part	▶	Establish a Measurement Reference	▶	Conduct a Measurement	▶	Review Measurement Data	▶	Report or Send Results
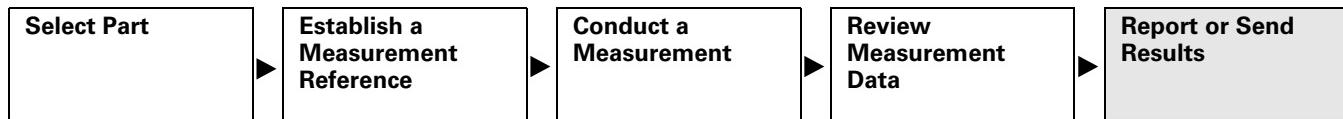
Printing reports

Reports of current dimension values, stored measurement results or ND 2100G setup parameters can be printed by displaying the desired screen and pressing the PRINT key. In some cases, the user will be prompted to provide additional information.

Sending data to a computer

Current dimension values, or a collection of stored dimension measurement results can be transmitted to a computer using the Send and SendRec functions in the Extra menu. Refer to "The Extra menu functions" on page 38 for more details regarding the Extra menu.

To send current dimension values:

▶ Press the MENU... soft key

▶ Press the EXTRA soft key

▶ Use the arrow cursor keys to highlight Send

▶ Press the ENTER key to send the current dimension values to a computer

To send stored measurement results:

▶ Press the MENU... soft key

▶ Press the EXTRA soft key

▶ Use the arrow cursor keys to highlight SendRec

▶ Press the ENTER key to send a file of stored measurement results
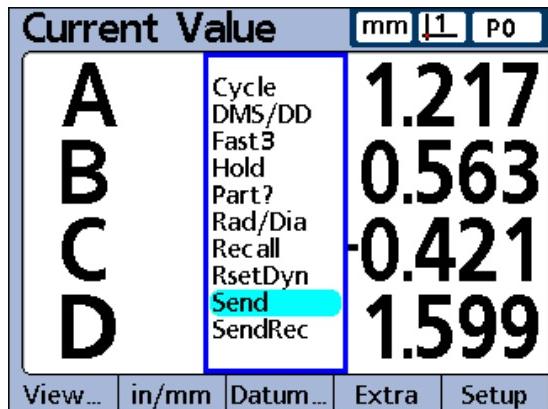
Use Send to send current values.
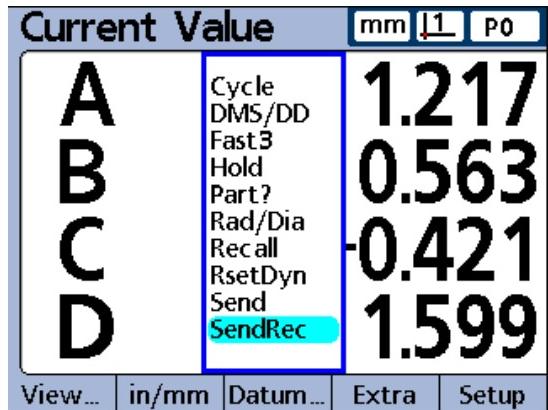
Use SendRec to send stored measurement values.

Data reports

Report type	Screen	User actions
Current dimensions (Numeric display)	DRO	▶ Press PRINT key
Graphs of dimension values (SPC subgroups = 1)	Graph...	▶ Press PRINT key
Histograms of dimension values (SPC subgroups = 1)	Histo...	▶ Press PRINT key
$\overline{x}$ chart of subgroup mean values (SPC subgroups> 1)	$\overline{x}$ chart	▶ Press PRINT key
r chart of subgroup range values (SPC subgroups>1)	r chart	▶ Press PRINT key
Current dimension values (Bar display)	Bar...	▶ Press PRINT key
Current dimension values (Dial display)	Dial...	▶ Press PRINT key
Data table multiple-dimensions	Data...	▶ Press PRINT key ▶ Respond to prompt
Data table single-dimensions	Data...	▶ Press DIMENSION soft key ▶ Press PRINT key ▶ Respond to prompt

Clearing stored measurement data

Stored measurement data can be cleared for a single part, or for all parts by pressing the LCD ON/OFF key.

⚠ Erased data cannot be restored.

To clear stored data for a single part:

▶ Select the desired part
▶ Press the LCD ON/OFF key
▶ Press the CLR PRT soft key

Stored data for the selected part will be erased.

To clear stored data for all parts:

▶ Select the desired part
▶ Press the LCD ON/OFF key
▶ Press the CLR ALL soft key

Stored data for all parts will be erased.

2

Installation, Setup,
Formulas and
Specifications

2.1 ND 2100G Shipment Contents

The contents of your ND 2100G shipment are described below. Repackaging instructions are also included for return shipments for distributors and OEM customers that are configuring an ND 2100G and shipping it to an end-user.

> Save the ND 2100G packaging materials for possible return shipment or shipment to an end user.

Items included with the ND 2100G

The following items are shipped with the ND 2100G:

- ND 2100G instrument
- Mounting stand hardware
- Power cord
- ND 2100G Quick Reference Guide
- Warranty registration card

Optional items possibly included

The following items might be shipped with your ND 2100G, depending on the options and accessories ordered at the time of purchase:

- Remote foot switch
- Remote keypad
- ND 2100G Protective cover
- QUADRA-CHEK Wedge communication software

> If any components were damaged in shipment, save the packaging materials for inspection and contact your shipping agent for mediation. Contact your HEIDENHAIN distributor or OEM for replacement parts.

Repackaging the ND 2100G

When shipping the ND 2100G on to an end-user, repackage all ND 2100G components in the original packaging as received from the factory.

> ⚠ The original packaging must be duplicated and the LCD must be inserted face-up to prevent damage to the screen.

> ➡ It is not necessary to ship the mounting stand and hardware with the instrument when returning the ND 2100G for service.

- Connect the mounting screws and washer to the ND 2100G instrument

- Replace the contents of the cardboard box insert if shipping the ND 2100G on to an end-user. The cardboard box can be empty if returning the ND 2100G to the factory for service.

- Repackage the instrument, foam and cardboard box insert as originally shipped from the factory. The instrument should be oriented face-up in the carton.

- Replace the warranty card and slip sheets originally found at the top of the carton when shipping on to an end-user. The "Before you begin" slip sheet should be inserted last.

2.2 Hardware Installation

The ND 2100G is easy to install in a variety of measurement applications. This section describes how to install the ND 2100G hardware.

Assembling the mounting stand

The ND 2100G is secured to the swivel slots of the mounting stand by a shoulder screw, a cap screw and associated washers.

To assemble the ND 2100G to the mounting stand as shown, and then tighten the cap screw (**5**) and washers (**3** & **4**) so that the ND 2100G will be secure when adjusted to the desired tilt position.

▶ Tighten the shoulder screw (**1**)

▶ Tighten the cap screw (**5**) and washers (**3** & **4**) so that the ND 2100G will be secure when adjusted to the desired tilt position

▶ Adjust the ND 2100G to the desired tilt position

Benchtop location and mounting

Rest the ND 2100G on a flat, stable surface, or bolt it to a stable surface from the bottom using four 10/32 screws fastened in the pattern shown at the right.

The dimensions are shown in millimeters.
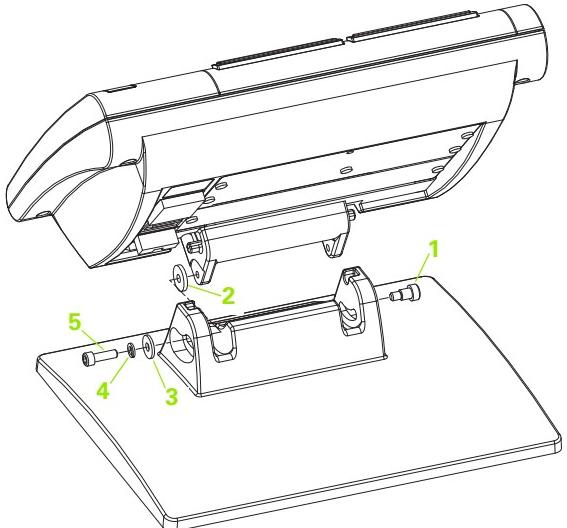
Mounting stand assembly.
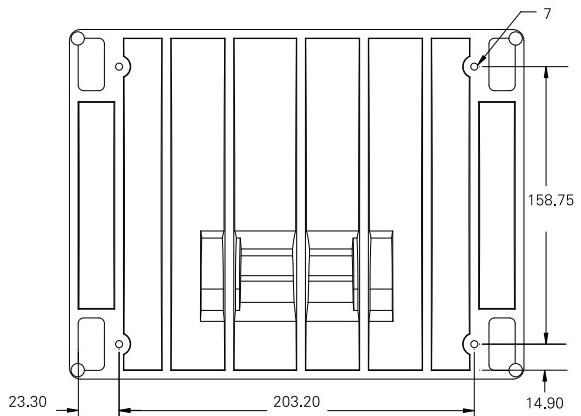
Mounting hole pattern.

Arm mounting (optional)

Secure the arm mount adapter to the ND 2100G and bolt the adapter and ND 2100G to the arm as shown at the right.
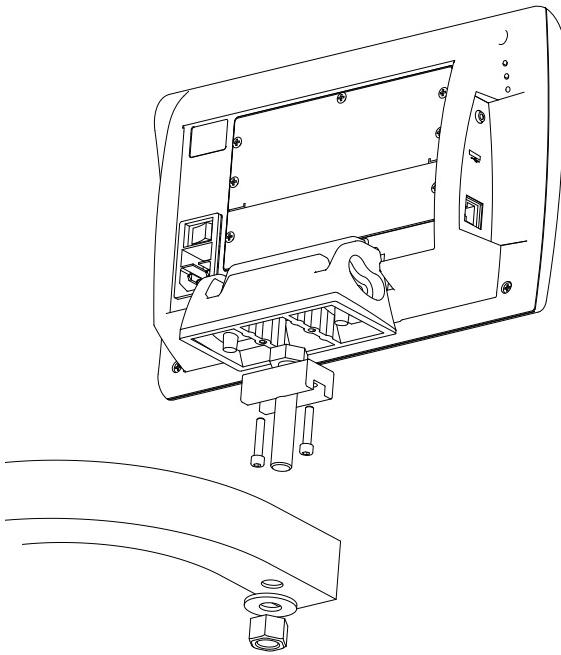
Optional arm mounting.

Connecting power

Connect the ND 2100G to power through a high-quality power surge suppressor. Surge suppressors limit the amplitude of potentially damaging power line transients caused by electrical machinery or lightning, and protect the ND 2100G from most power line transients that can corrupt system memory or damage circuits.

Do not locate the power cord where it can be walked on or will create a tripping hazard. Connect the 3-wire power plug to only a 3-wire grounded power outlet.

> ⚠ Never connect 2-wire to 3-wire adapters to the power cord or remove the third ground wire to fit the plug into a 2-wire electrical outlet. Modifying or overriding the third-wire ground creates a safety hazard and should not be permitted.

Power switch, fuse and connector.

The power connector assembly includes:

1 Power switch
2 Fuse compartment
3 Power cord connector

> ⚠ Always disconnect the power cord from the source of AC power before unplugging it from the ND 2100G power connector. The AC voltage available at electrical outlets is extremely dangerous and can cause serious injury or death.

Connecting channel inputs

Channel input devices are attached to standard interface connectors or to the RS-232 port on the rear of the ND 2100G. Many device interfaces are available to match the wide variety of encoder and transducer devices that can be used with the ND 2100G. The number and type of channel input connectors will vary depending on the application. Four standard interface connectors are shown here as examples.

1   Channel input connections

Connect the channel input devices tightly to their connectors. A channel number is provided near each connector.

Channel input devices must be configured using the Channels setup screen. Refer to "Channels setup screen" on page 99

Systems can be configured at the factory to support a combination of single-channel and multi-channel RS-232 networked input devices.

These configurations can include one of the following:

■ 1, 4 or 8 single-input channels

■ Up to 16 networked RS-232 input channels

■ A combination of single-input channels and networked RS-232 input channels for a total of up to 16 channels

To connect channel input cables:

▶ Verify that the ND 2100G is off

▶ Connect the channel inputs tightly to their connectors. If the connectors include mounting screws, do not overtighten them.
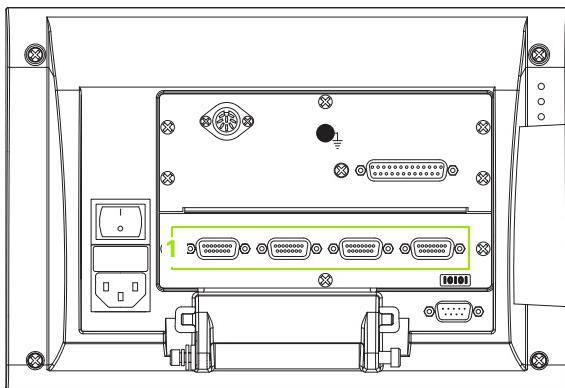
Channel input connectors.

Connecting a computer

Measurement result data can be sent to a computer over the RS-232 port (**1**) using a serial cable that does not include crossed wires.

To connect a computer:

▶ Verify that the ND 2100G and the computer power are off

▶ Connect a computer COM port to the ND 2100G RS-232 serial port (**1**) using a standard straight-through serial cable. Make sure the cable connectors are tight, but do not overtighten the connector screws.

▶ Apply power to the computer, and then the ND 2100G. The ND 2100G default settings for communication over the RS-232 serial port (**1**) are:

Baud rate	115,200
Word length	8 bits
Stop bits	1 bit
Parity	None

RS-232 connector.

▶ Launch the computer application that will be used to communicate with the ND 2100G, and configure the communication properties of the COM port to match those of the ND 2100G
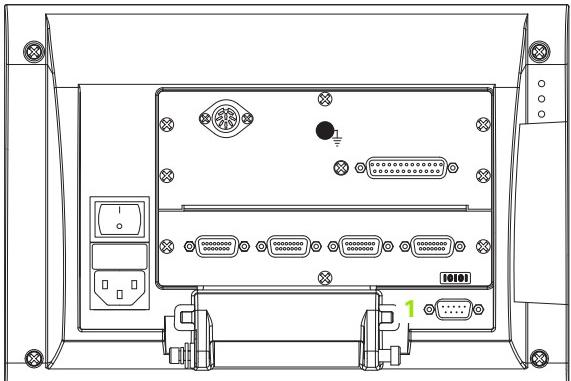
Connecting headphones and USB printer

Connecting headphones

Audio alerts can be sent to headphones in areas that are noisy and make it difficult to hear, or are quiet where audio alerts might create a disturbance.

The speaker jack (**1**) is located on the side of the ND 2100G.

To connect headphones:

▶ Verify that the ND 2100G power is off. Plug the headphones into the speaker jack (**1**) on the side of the enclosure.

▶ Make sure the headphone plug is fully inserted

Connecting a USB printer

The ND 2100G supports certain USB printers. Printer models are specified by HEIDENHAIN at the time of purchase, or approved by HEIDENHAIN later.

The USB port (**2**) is located on the side of the ND 2100G.

To connect the USB printer:

▶ Verify that the ND 2100G and printer power are off. Connect the USB printer to the USB Type A port (**2**) on the side of the enclosure.

▶ Make sure the USB cable plug is fully inserted
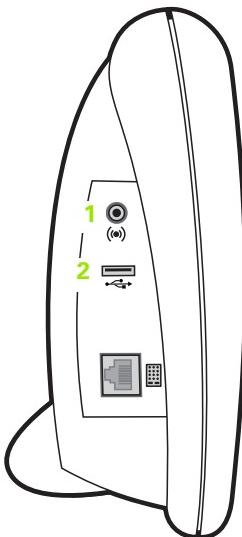
Headphone and USB connectors.

Connecting an optional foot switch or remote keypad

The optional foot switch and remote keypad are connected to the RJ-45 connector (**1**) on the side of the ND 2100G.

Often, only the optional foot switch or remote keypad is used. However, two options can be connected simultaneously using a RJ-45 splitter (**2**).

> RJ-45 splitters are available from most retail electronics stores.

The foot switch and remote keypad can be used individually or in combination:

■ foot switch

■ foot switch and remote keypad

When the foot switch and remote keypad are connected using the RJ-45 splitter (**2**), all operating functions of each device are retained. However, the switch shares Hot Key mapping with the number keys 7 and 8 of the remote keypad. As a result, functions assigned to the two switch contacts will also be mapped to remote keypad numbers 7 and 8.

> Refer to "Hot Keys setup screen" on page 141.

To connect the foot switch or remote keypad:

▶ Verify that the ND 2100G is off

▶ Plug an RJ-45 splitter (**2**) into the ND 2100G RJ-45 connector (**1**) if multiple devices will be used

▶ Connect the RJ-45 plug of the devices into the RJ-45 splitter (**2**) if multiple devices will be used, or directly into the ND 2100G RJ-45 connector (**1**) if only a single device will be used
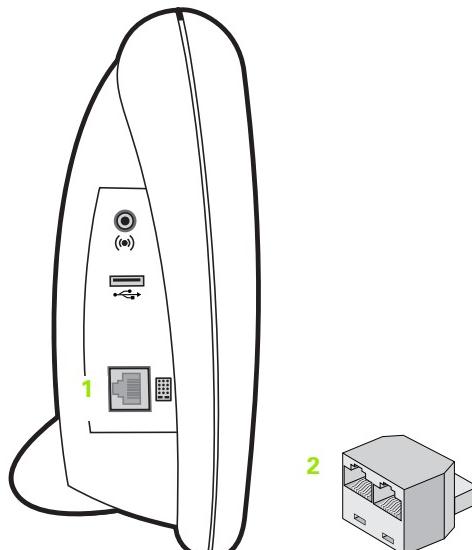
RJ-45 connector and RJ-45 splitter.

Optional foot switch and remote keypad.

2.3 Software setup

The operating parameters of the ND 2100G must be configured prior to using the system for the first time, and any time part measurement, reporting or communication requirements change. Day to day use of the ND 2100G does not require reconfiguration of system settings.

⚠️ Parameter changes made in any of the setup screens can change the operation of the ND 2100G. For this reason critical setup parameters are password protected. Only qualified personnel should be given password access to setup screen parameters. Refer to "Supervisor setup screen" on page 161 for unlocking of password protected setup functions.

Software can be configured manually using the Setup menu screens, or automatically by loading a settings file saved after a previous setup session. Settings files are loaded from USB drives.

Parameters configured in setup screens will be retained until:

■ The data-backup battery is changed

■ The data and settings are cleared by maintenance personnel

■ Parameters are changed using the Setup menu screens

■ Certain software upgrades are performed

■ Previously saved settings files are loaded

Setup menu

Most operating parameters of the ND 2100G are configured using
screens and data fields accessed from the Setup menu. Highlighting
Setup menu items (**1**) on the left side of the setup screen displays the
corresponding setup parameter data fields (**3**) and choice fields(**2**) on
the right side of the screen.

Setup menu features:

1   Setup menu item: Setup screen name
2   Setup choice field: Setup choices are made
3   Setup data field: Setup data are entered
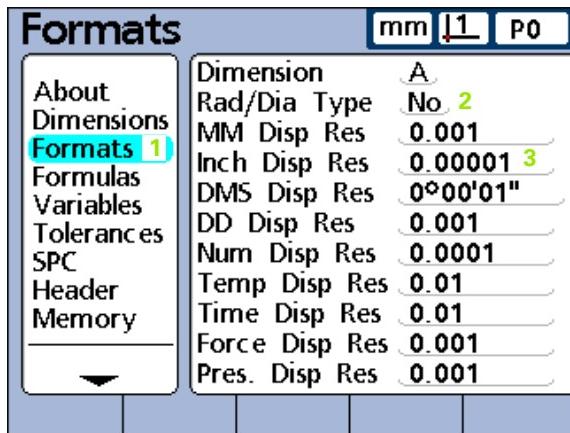
Setup screen menu items, data fields and choice
fields.

Accessing and navigating the Setup menu

To access the Setup menu:

▶ Press the MENU... soft key
▶ Press the SETUP soft key. The Setup menu is displayed.
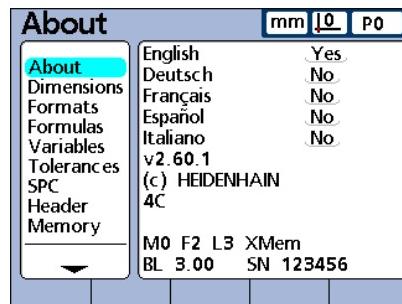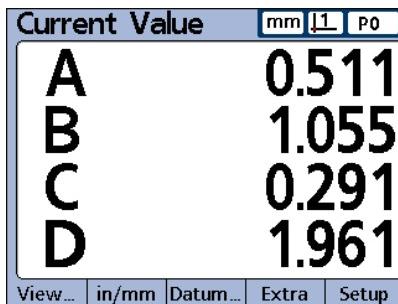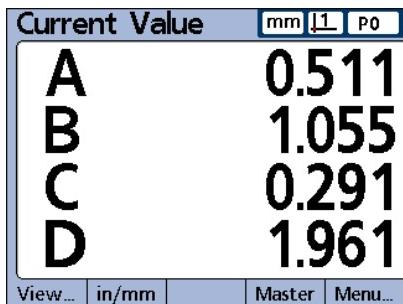
Press the MENU... soft key then press the SETUP soft key to display the Setup menu.

To navigate the Setup menu:

▶ Use the up and DOWN ARROW cursor keys to scroll through the Setup menu screens
▶ Use the RIGHT ARROW cursor key to access setup screen menu items
▶ Use the UP and DOWN ARROW cursor keys to scroll through and select a menu item
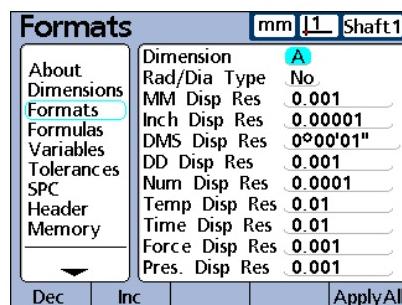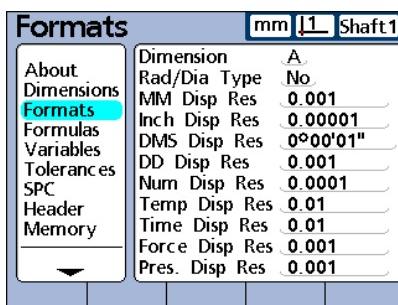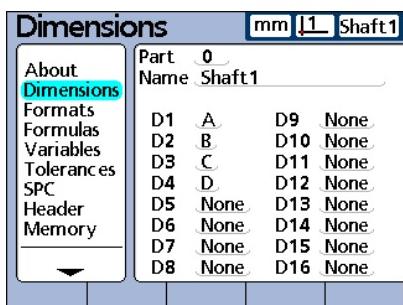
Pressing the DOWN ARROW cursor highlights next menu item, then pressing the RIGHT ARROW cursor highlights top screen parameter.

Using dimension keys in the setup mode

The functions of the dimension keys change to speed setup screen navigation when the Setup menu is displayed. Dimension keys can be used to move to the top or bottom of the Setup menu or to page up or down through the Setup menu as shown here.

	Setup mode function
1	Menu top
2	Page up
3	Page down
4	Menu bottom
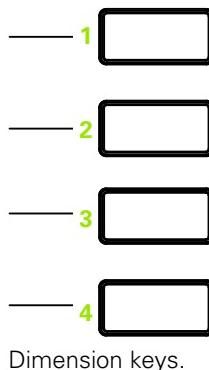
Dimension keys.

Entering data into setup fields

Enter numbers into the highlighted setup screen fields using the numeric keypad.

Highlight a setup field and use the numeric keypad to enter a number.

The Alpha Entry screen will be displayed when alpha character entry is required. Enter alpha characters into the Alpha Entry screen by highlighting a letter and then pressing the ENTER key. Once all desired characters have been entered press the FINISH key to complete the entry.

Highlight a character then press the ENTER key to enter the character.

Deleting data entries

Press the CANCEL key to erase the last (right-most) numeric digit or alpha character in the selected data field.
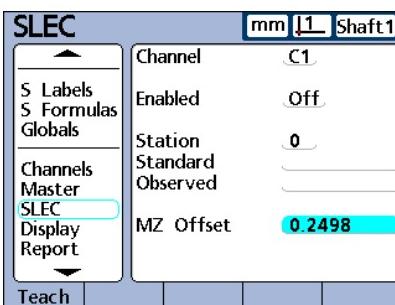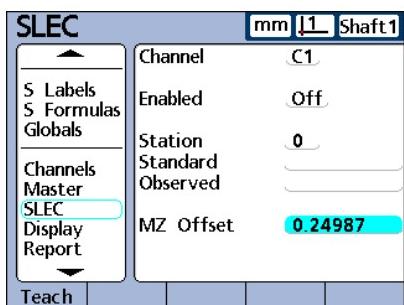
Highlight a data field and press the CANCEL key to erase the right-most digit or character.

Entering setup parameters

Setup parameters and functions are displayed above the soft keys across the bottom of the screen.

Changing the channel or dimension number

Often setup parameters and functions are related to specific channels or dimensions. When a channel or dimension is highlighted on the setup screen, the channel or dimension number can be increased or decreased by pressing the INC or DEC soft key or by pressing the LEFT or RIGHT WIDE key.

	Key	Function
1	LEFT WIDE key	Decreases the channel or dimension.
2	RIGHT WIDE key	Increases the channel or dimension.
3	DEC soft key	Decreases the channel or dimension.
4	INC soft key	Increases the channel or dimension.
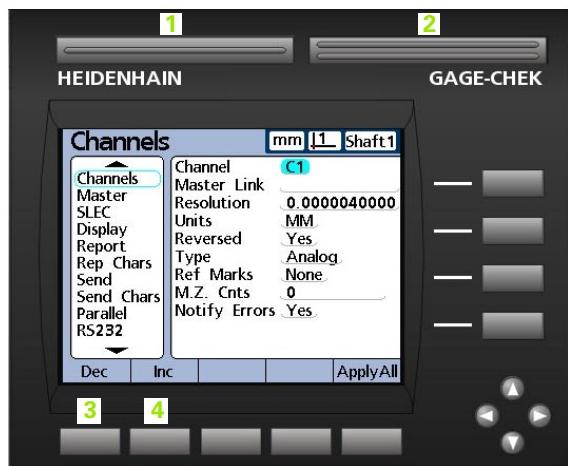
Entering parameters

When a setup parameter field (**1**) is highlighted, setup alternatives are shown above the soft keys across the bottom of the screen (**2**). Press the soft key under the desired setup alternative to enter the parameter.

Parameters and options are shown here:

1 Highlighted parameter field
2 Parameter alternatives
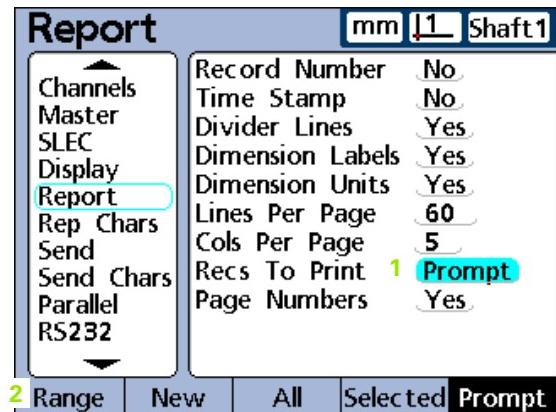
Copying parameters to other parts, dimensions or channels

A single highlighted parameter or all parameters of the current part, dimension or channel can be copied to all others by pressing the APPLY ALL soft key.

If all part, dimension or channel parameters are already the same for the selected setup category, the APPLY ALL soft key will be grayed-out.

Copy all parameters by pressing the APPLY ALL soft key when the part, dimension or channel name is highlighted.

Copy a single parameter by pressing the APPLY ALL soft key when only a single parameter is highlighted.

Saving a parameter and advancing to the next

Press the ENTER key to save the highlighted value and advance to the next parameter.

Press the ENTER key to store the highlighted value and advance to the next parameter.

Saving a parameter and returning to the Setup menu

Press the FINISH key to store the value and return to the Setup menu.

Press the FINISH key to store the highlighted value and return to the Setup menu.

Discarding changes and returning to the Setup menu

Press the QUIT key to return to the Setup menu on the left half of the screen without saving changes.

Press the QUIT key to discard changes and return to the Setup menu.

Leaving the Setup menu

Press the FINISH key repeatedly to conclude the setup session and return to the home screen.
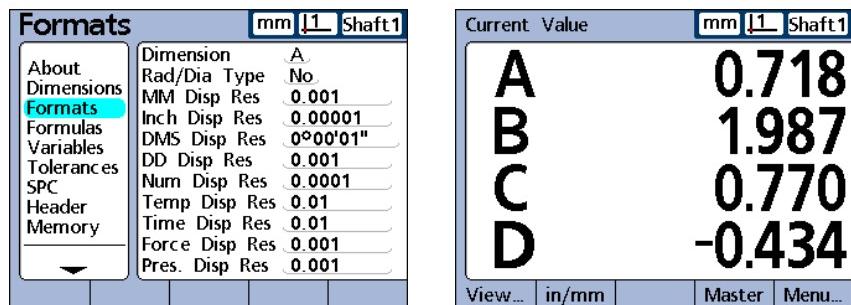
Press the FINISH key repeatedly to leave the Setup menu and return to the home screen.

Printing ND 2100G setup configurations

Print all ND 2100G configuration settings and formulas as a text file by pressing the PRINT key while displaying any setup screen.

Saving or loading ND 2100G configurations

Insert a USB drive into the USB port, navigate to the Supervisor setup screen, highlight the Password field and enter the password if necessary. Press the SAVEX soft key to save the current configuration as an .xml file, or press the LOADX soft key to load a previously saved .xml configuration file from the USB drive.
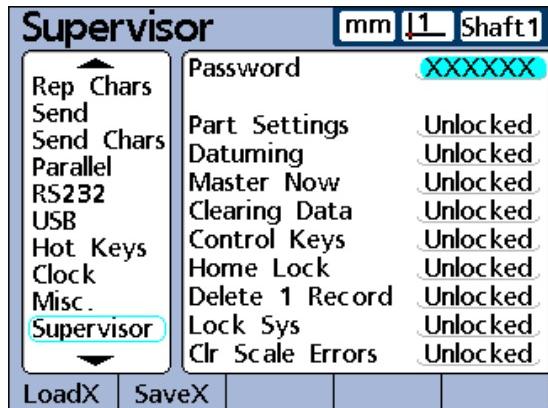
Minimum setup requirements

The minimum setup steps required to begin conducting measurements are diagrammed below. Additional setup will be required to utilize the full SPC, reporting, data communication and other capabilities of the ND 2100G system. The screens required for the initial setup are described in the remainder of this chapter.

Enter supervisor password	→	Configure input channels	→	Assign part & dimension labels	→	Configure display of data	→	Specify display resolution	→	Create dimension formulas
Supervisor setup screen		**Channels** setup screen		**Dimensions** setup screen		**Display** setup screen		**Formats** setup screen		**Formulas** setup screen
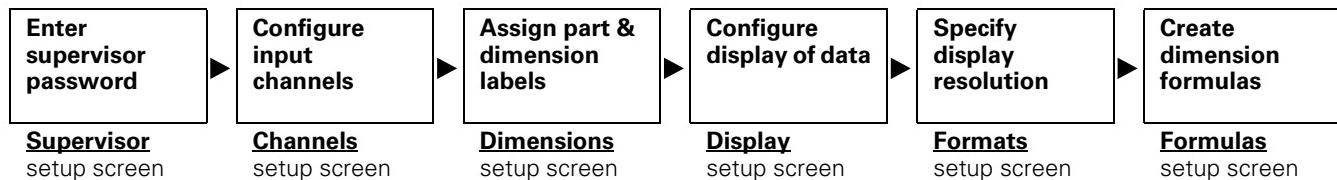
Setup screens

Setup screen descriptions are presented in the order of their appearance in the setup menu. However, the first time the ND 2100G is configured the order of setup screen use should follow the essential setup requirements diagram, and then continue in the order that best satisfies the application or the user's preferences. The subsequent use of setup screens will probably be infrequent and will address application requirements or hardware changes.

About setup screen

The About setup screen contains selections for changing the language of text displayed on the LCD, included in transmitted data and printed on reports. Software and hardware version information and the number of input channels are displayed on the bottom of the screen.

To specify the displayed language:

▶ Highlight the desired language
▶ Press the YES soft key to select the language
▶ Press the FINISH key
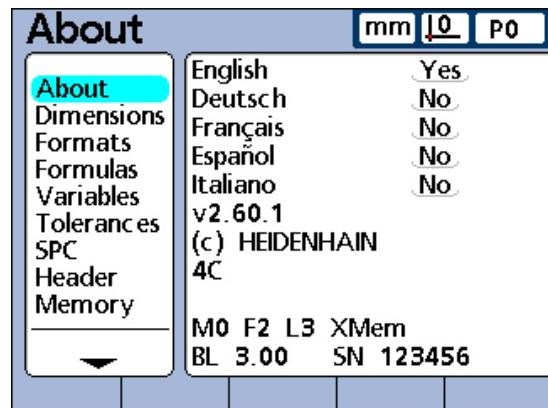
About setup screen.

Dimensions setup screen

The Dimensions setup screen contains fields for defining the part and dimension labels displayed on the screen, included in transmitted data, printed on reports and stored in the ND 2100G database for up to 100 individual parts. Dimensions must be defined prior to other setup activities and conducting tests.

Part numbers consist of up to 2 numeric digits in the range from 0 to 99 entered by the system in sequence as new parts are added. Part and dimension labels consist of up to 8 alphanumeric characters entered from the character entry screen and the numeric keypad. Part names are shown in reports, but only part numbers are shown in formulas. Completed dimension labels of one part can be copied and applied to another.

Dimensions setup screen.

> Deleting part numbers will erase any data associated with the part's dimensions in the ND 2100G database. Deleting a part number also decrements the part numbers of any higher numbered parts. This will cause data for a part number to be different as it now contain data from a previously higher numbered part.

Creating part numbers

Up to 100 (software) parts can be created in the ND 2100G. Multiple parts are useful when the number of measurements performed on one physical part is large and could be divided into categories, or when different physical parts must be measured.

To create a new part number:

▶ Highlight the Part field

▶ Press the NEW soft key

Selecting part numbers

To select an existing part number:

▶ Press the LEFT WIDE key or the DEC soft key to navigate down through a list of parts

or

▶ Press the RIGHT WIDE key or the INC soft key to navigate up through a list of parts

Labeling parts and dimensions

Part labels contain up to 8 alpha numeric characters. Dimension labels contain up to 3 alpha numeric characters. Alpha numeric characters are in the range from A to Z and can be upper or lower case. Numeric characters are in the range from 0 to 9. The order of alpha and numeric characters in a label is defined by the user. The process of labeling a part or dimension is identical.

To label a part or dimension:

▶ Highlight the Name field or a Dimension field

▶ Press the LABEL soft key. The Alpha Entry screen is displayed.

▶ Create the desired label using the Alpha Entry screen and/or the numeric keypad

▶ Press the FINISH key

> Labels should be meaningful by reflecting the measurement application when possible.

Defining visible and hidden dimensions

Dimensions are defined as visible by default, displayed on the screen and stored in the database. Dimensions can also be defined as hidden for use in performing operations and not displayed. Hidden dimensions are not printed on reports or sent to computers as data files. Visible and hidden dimensions use the same naming convention.

To create a visible dimension:

▶ Highlight a dimension field

▶ Press the VISIBLE soft key. Visible dimensions are displayed.

▶ Press the LABEL soft key

▶ Create a label using the Alpha Entry screen and/or the numeric keypad

▶ Press the FINISH key

To create a hidden dimension:

▶ Highlight a dimension

▶ Press the HIDDEN soft key. Hidden dimensions are displayed.

▶ Press the LABEL soft key

▶ Create a label using the Alpha Entry screen and/or the numeric keypad

▶ Press the FINISH key

> More details regarding the use of hidden dimensions are contained in the Formulas section of this chapter on page 163.

Copying dimension parameters to other parts

Dimensions assigned to one part can be copied to another to save setup time when similar or identical measurements must be performed on new parts.

To copy dimensions to a new part:

▶ Highlight the Part field

▶ Press the COPY TO soft key. The labels, formulas and all other parameters will be copied to the next new part. Database records will not be copied. A pop-up screen will show the next part number.

▶ Press the OK soft key to copy the labels

▶ Press the OK soft key to return to the Dimension setup screen

Deleting parts

Parts can be deleted when it is no longer necessary to store old measurement results in the ND 2100G. Deleting old part data makes more system memory available for new data and dimension formulas.

To delete a part:

▶ Highlight the Part field

▶ Press the INC or DEC soft key to select the desired part

▶ Press the DEL soft key

▶ Press the YES soft key to delete the part

Formats setup screen

The Formats setup screen contains fields for specifying the display format and display resolution for dimensions of the currently selected part. Selections of radius and diameter measurement types are also provided.

Specifying a dimension

▶ Highlight the Dimension field

▶ Press the DEC or INC soft key to select the desired dimension

▶ Press the ENTER key

Specifying radius or diameter

Radius or diameter measurements can be specified for cylindrical and spherical parts or parts with curved surfaces. When radius or diameter measurements are specified, the corresponding symbol will be displayed near the associated dimension on the DRO screen.

The display can be toggled between Radius and Diameter later from the Home screen using the Extra menu. Toggling the display mode changes it until the system power is cycled off and then on again. The default display mode upon powering the ND 2100G is specified in the Formats setup screen.

To specify radius or diameter:

▶ Highlight the Rad/Dia Type field

▶ Press the RADIUS or DIAM. soft key to specify a radius or diameter measurement type

▶ Press the ENTER key
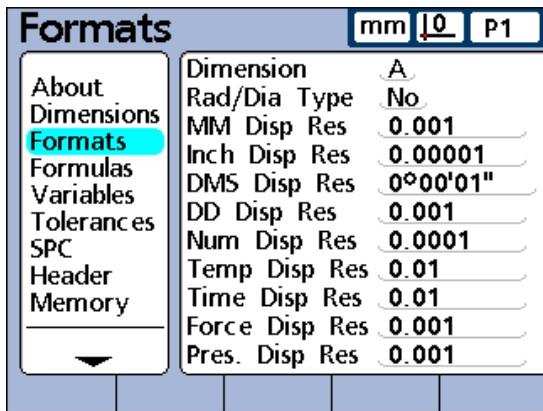
Formats setup screen.

Display resolution

The display resolution fields are used to specify how numbers are shown on the DRO screen. Displayed numbers will be rounded as the display resolution is decreased. This table illustrates how the display of numbers is governed by the display resolution setting.

Channel input	Display resolution	Number displayed
1.567	0.0001	1.5670
1.567	0.001	1.567
1.567	0.01	1.57
1.567	0.1	1.6
1.567	1	2

Measurement resolution should not be higher than the input channel resolution. Specifying display resolutions that are higher than the channel resolutions can lead to misleading displays of dimension values.

To specify a display resolution:

▶ Highlight a display resolution (Disp Res) field
▶ Using the numeric keypad, enter the desired display resolution
▶ Press the ENTER key

Formulas setup screen

The ND 2100G uses formulas to define and display dimensions based on channel inputs.

These formulas are constructed by the user to display:

- One dimension based on one channel
  ex. A=C1

- One dimension based on multiple channels
  ex. A=C1+C2

- Multiple dimensions based on one channel
  ex. A=C1
      B=2*pi*C1

- Multiple dimensions based on multiple channels
  ex. A=C1
      B=C2
      C=C1*C2

Formulas can be constructed that display a channel as a dimension, or that calculate a dimension from one or more channels using powerful math, logic or other functions.

Dimension formulas are unique to the part they are created in. For example, a dimension formula created in part 0 cannot be used in part 2. However, system dimensions are described later in this chapter and can be used across all parts.
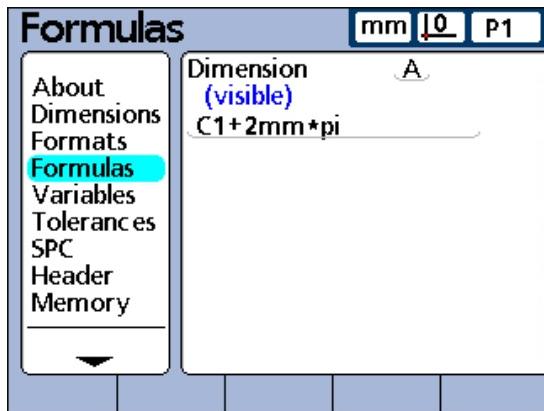
> ➡ Refer to "Formulas" on page 163.

Formulas setup screen.

Variables setup screen

Formulas use variables as symbols or names that represent values.

For example, in the expression:

C1+Var1()

Var1() is a variable, its value is flexible and is determined by operations on a different formula line for the current part. Variables can represent numeric constants, channel input values, dimension values or the results of a wide variety of math operations.

Variables are important in formula creation because they enable users to create flexible formulas. Rather than including data directly into a formula, a user can use variables to represent the data. Then, when the formula is executed, the variables are replaced with actual data. This makes it possible for the same formula to process different sets of data as conditions change.

The Variables setup screen allows the user to see the current value of any of the 20 possible variables. Variables that are not defined elsewhere by formulas can be set to constant values in this screen by highlighting a variable field and entering the value. Variables that are defined by formulas cannot be changed in the Variable setup screen.

Variables are unique to the part they were created in. For example, a variable created in part 0 cannot be used in part 2. Global variables, discussed later in this chapter, can be used across all parts.

> ➡️ Variable functions are defined in the Formula setup screen on page 82. Formulas are explained in the Formulas section on page 163.

Variables setup screen.

Tolerances setup screen

The tolerances setup screen contains fields for specifying nominal values, upper/lower warnings, upper/lower limits and minimum/maximum bar graph levels for each dimension. An audio alert can also be specified for warnings, limits, or both.

Tolerance ranges are indicated numerically and by bands of color on the Current Value bar and dial screens.

The default bar and dial displays show Pass values in green, Warning values in yellow, and Fail values in red.

These pass, warning and fail levels are shown in the bar graph of current values to the right, and explained in the table below:

Tolerance	Description
Pass	Above low warning and below high warning. Pass values fall within the specified range of acceptable values.
Warning	Outside the range of pass values, but not at or beyond the specified acceptable limits. Warnings indicate the need to evaluate the process to prevent the future generation of unacceptable, or failed parts.
Fail	Outside the specified range of acceptable limits specified.
Max/Min	Highest and lowest graph scale values. These values determine the range of values plotted on the graph. This range should be greater than the range limits of acceptable limits.

> The colors used to indicate pass, warning and fail can be changed using the Display setup screen on page 123.
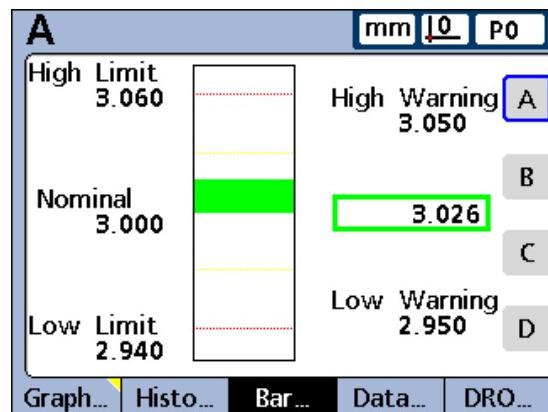
To specify a dimension for tolerancing:

▶ Highlight the Dimension field
▶ Press the DEC or INC soft key to select the desired dimension

Tolerances setup screen.

Bar graph tolerances.

Nominal values with tolerances

Nominal values with tolerances can be specified as a nominal value between +/- tolerances, or as a nominal value with ++/- - tolerances distributed entirely on the plus side or entirely on the minus side of the nominal value.

Nominal with +/- tolerances

A nominal value is displayed between plus and minus tolerances.
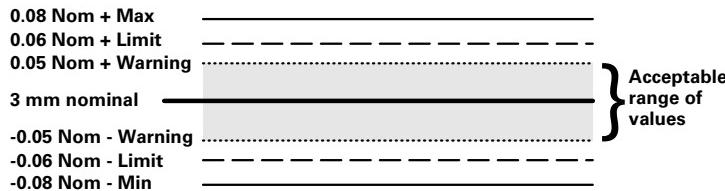
To specify a nominal value with +/- tolerances:

▶ Highlight the Dimension field

▶ Press the +/- soft key to specify a nominal value with +/- tolerances

▶ Highlight the desired tolerance field

▶ Enter the desired tolerance value

▶ Press the ENTER key

▶ Repeat until all tolerances are entered

This example screen contains the nominal value and tolerances listed below:

■ Nominal = 3.0000 mm

■ Warning tolerance = ± 0.050 mm

■ Limit tolerance = ± 0.060 mm

■ Max tolerance = ± 0.080 mm

> Values specified using the +/- Tolerances setup screen will also be converted to fixed limits if the Limits soft key is pressed.
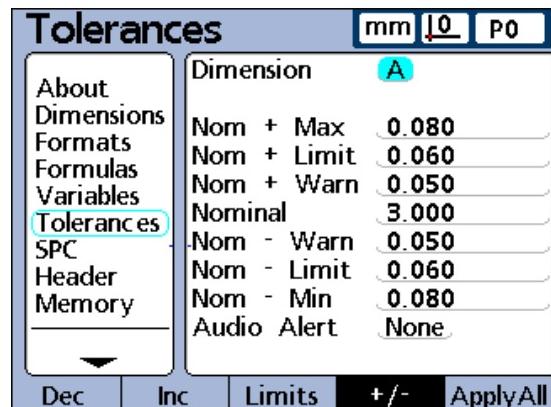
Nominal and +/- tolerances for dimension A.

Nominal with ++ tolerances

A nominal value is displayed with tolerances entirely on the plus side of nominal.

0.08 Nom + Max	————————————————
0.06 Nom + Limit	— — — — — — — — — —
0.05 Nom + Warning	····························
0.03 Nom - Warning	····························
0.02 Nom - Limit	— — — — — — — — — —
0.00 Nom - Min	————————————————
3 mm nominal	━━━━━━━━━━━━

To specify a range of tolerances above the nominal value (+ Tolerance):

▶ Press the +/- soft key

▶ Enter the high end of the positive tolerance range into the + Max, + Limit and + Warn fields

▶ Enter the Nominal value

▶ Enter the low end of the positive tolerance range into the -Warn

▶ Press the ++/-- soft key to change the fields to + Warn

▶ Repeat this procedure for the - Limit and - Min fields. This establishes the lower end of the positive range of tolerances.
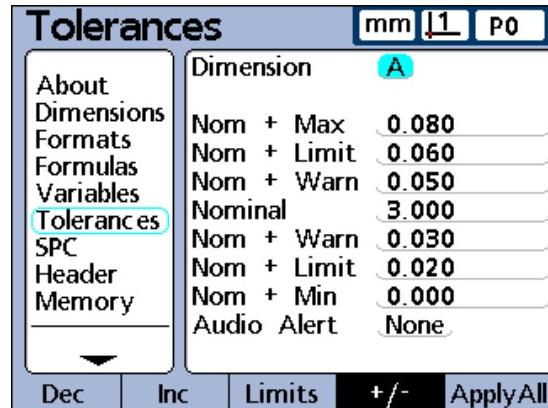
Nominal and ++ tolerances for dimension A.
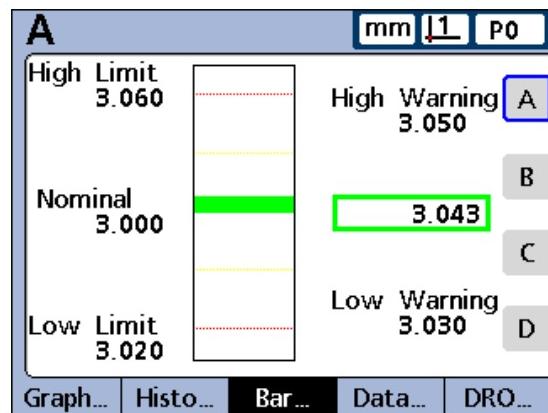
Bar graph showing ++ tolerances.

Nominal with -- tolerances

A nominal value is displayed with tolerances entirely on the minus side of nominal.

3 mm nominal
-0.01 Nom + Max
-0.02 Nom + Limit
-0.03 Nom + Warning

-0.05 Nom - Warning
-0.06 Nom - Limit
-0.07 Nom - Min

To specify a range of tolerances below the nominal value (- Tolerance):

▶ Press the +/- soft key

▶ Enter the low end of the negative tolerance range into the - Max, - Limit and -Warn fields

▶ Enter the Nominal value

▶ Enter the high end of the negative tolerance range into the + Warn field

▶ Press the ++ /-- soft key to change the field to - Warn

▶ Repeat this procedure for the + Limit and + Max fields. This establishes the upper end of the negative range of acceptable tolerances.
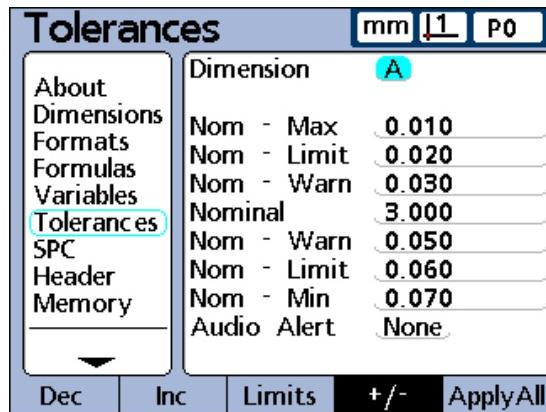
Nominal and -- tolerances for dimension A.
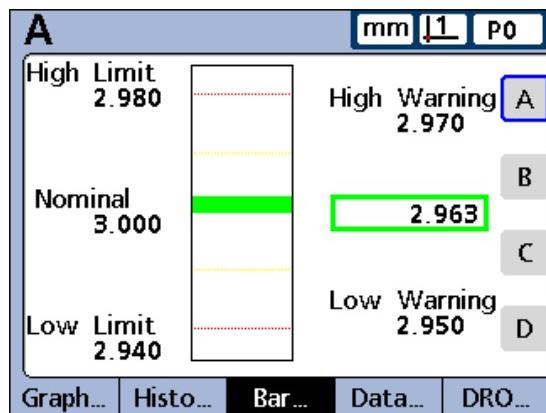
Bar graph showing -- tolerances.

Nominal with fixed limits

A nominal value is displayed between plus and minus fixed limits.

To specify fixed limits above and below a nominal value:

▶ Press the LIMITS soft key
▶ Highlight the desired tolerance field
▶ Enter the desired tolerance value
▶ Repeat for all tolerance values
▶ Press the FINISH key

The example below of 3 mm ± 0.005 mm is used to show a nominal value with fixed limits.

- Nominal = 3.000 mm
- High warning = 3.002
- Low warning = 2.998
- High limit = 3.004
- Low limit = 2.996
- Bar graph max = 3.005
- Bar graph min = 2.995

Nominal and fixed limit tolerances for dimension A.
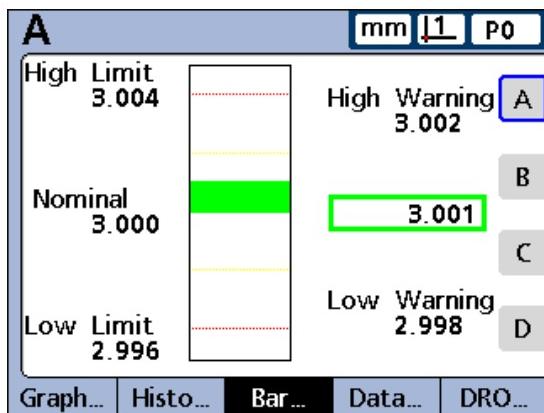
Bar graph showing fixed limit tolerances.

Specifying an audio alert

Audio alerts can be specified that sound when a dimension reaches warning and limit values.

The audio alert sounds when a warning or limit threshold is crossed, and will not sound again until the alert is reset by crossing the threshold again in the opposite direction.

Soft key	Description
NONE	No audio alerts.
WARNING	Audio alerts for tolerance or limit warnings.
LIMITS	Audio alerts for limit failures.
BOTH	Audio alerts for both; warnings and limit failures.

To specify an audio alert:

▶ Highlight the Audio Alert field

▶ Press the soft key that represents when you would like an audio alert activated. NONE, WARNING, LIMITS, BOTH.

Mirror values

Positive and negative Max and Warn values can be set automatically.

The UCL and LCL values in the SPC setup screen will also be changed.

To automatically set positive and negative Max and Warn values:

▶ Highlight the Nom+ Limit value field
▶ Use the numeric keypad to enter a limit tolerance
▶ Press the MIRROR soft key
▶ Press the FINISH key

New values will be:

Max = Limit + 5%

Warn = SPC screen Warning Per (%) of Limit

SPC screen UCL & LCL = Limit

In this example, the Limit is changed to 1.750. The resulting changes are:

Max = Limit + 5% = 1.837

Warn = SPC screen Warning Per (%) of Limit = 66% of Limit = 1.155

SPC screen ULC & LCL = Limit = 1.750

Nom+ Limit defined. All other values set automatically with the MIRROR soft key.

SPC UCL and LCL are changed to Nom+ and Nom- Limit.

SPC setup screen

The SPC setup screen contains fields for specifying statistical process control parameters including the Subgroup (sample) Size and Max (number of) subgroups stored, upper and lower mean control limits, and upper and lower range control limits. Record ID numbers can also be viewed or changed.

Subgroup size

To specify a subgroup size:

▶ Highlight the Subgroup Size field

▶ Enter the desired subgroup size from 1 to 10 samples

▶ Press the ENTER key

SPC parameters in the lower half of the screen and graphs of data displayed on the screen are different for subgroup sizes of 1 and subgroup sizes greater than 1.

The differences between subgroups of 1 and subgroups greater than 1 are described later in this SPC screen discussion.

Max subgroups

Max subgroups specifies the maximum number of subgroups to be stored for the specified dimension. Each dimension can store samples in from 2 to 1000 subgroups.

To specify the maximum number of subgroups:

▶ Highlight the Max Subgroups field

▶ Enter the maximum number of subgroups to be stored for the specified dimension. Each dimension can store samples in from 2 to 1000 subgroups.

▶ Press the ENTER key

SPC setup screen. Subgroup Size = 1

SPC setup screen. Subgroup Size > 1

Graph points

Graph Pnts (Points) is the maximum number of points that will be plotted on graphs of subgroups for the specified part.

To specify Graph Pnts:

▶ Highlight the Graph Pnts field

▶ Enter the maximum number points to be graphed

▶ Press the ENTER key

> When there are fewer graph points specified than subgroups, the resulting dimension graphs might need to be scrolled to view all the subgroup data. Refer to Chapter 1: Operation for details regarding viewing and scrolling graphs.

Next record ID

Record ID numbers are displayed on graphs and can be included in printed reports and transmitted data.

Normally, the Next Record ID field starts at 1 and is automatically incremented by the system each time a new record is stored. However, the Next Record ID field can be set to any value by the user to restart a new database at a specified record number, or for a variety of other reasons. Enter the Next Record ID to restart the database at a new number. Entering 999,999,999 will prevent any data from being recorded in the database.

To specify the Next Record ID:

▶ Highlight the Next Record ID field

▶ Use the numeric keypad to enter the desired ID for the next record

▶ Press the ENTER key

Dimension

To specify the dimension used for the current SPC settings:

▶ Highlight the Dimension field

▶ Press the DEC or INC soft key until the desired dimension is displayed in the field

▶ Press the ENTER key

UCL and LCL

The UCL and LCL fields are displayed when the subgroup size is 1. Subgroup sizes greater than 1 change the lower half of the SPC screen to display mean and range control limits that are described later in this section. By default, the UCL and LCL fields display the Upper and Lower Control Limits specified earlier on the Tolerances setup screen. The limits are used by the ND 2100G graphing software to scale the value axis of SPC graphs.

> The UCL and LCL values shown on the SPC setup screen should not be altered after initial setup. Change them only if you are certain that your application requires different values.

$\bar{x}$, r Ucl and Lcl

The $\bar{x}$ Ucl and Lcl and r Ucl and Lcl fields are displayed when the subgroup size is greater than 1.

Ucl and Lcl

The $\bar{x}$ Ucl and $\bar{x}$ Lcl are the likely limits of the values of $\bar{x}$ in future subgroups. These limits are either entered manually or calculated, using the RECALC soft key, on the basis of existing subgroup data. The $\bar{x}$ Ucl and $\bar{x}$ Lcl values are displayed as horizontal lines on the $\bar{x}$ chart and used to generate SPC limit alarms.

To manually specify $\bar{x}$ Ucl and $\bar{x}$ Lcl limits:

▶ Highlight the $\bar{x}$ Ucl or $\bar{x}$ Lcl field
▶ Use the numeric keypad to enter the desired $\bar{x}$ Ucl or $\bar{x}$ Lcl
▶ Press the ENTER key

Recalculating $\bar{x}$ Ucl and Lcl

Once subgroup data has been collected, the upper and lower control limits can be simultaneously recalculated.

To recalculate $\bar{x}$ Ucl and $\bar{x}$ Lcl:

▶ Highlight the $\bar{x}$ Ucl field
▶ Press the RECALC soft key
▶ Press the ENTER key. Both the $\bar{x}$ Ucl and $\bar{x}$ Lcl are recalculated

r Ucl and Lcl

The r Ucl and r Lcl are the likely limits of the values of the r of future subgroups calculated on the basis of existing subgroup data. These limits are either entered manually or calculated, using the RECALC soft key, on the basis of existing subgroup data. The r Ucl and r Lcl values are displayed as horizontal lines on the chart and used to generate SPC limit alarms.

To manually specify r Ucl and r Lcl:

▶ Highlight the r Ucl or r Lcl field

▶ Use the numeric keypad to enter the desired r Ucl or r Lcl

▶ Press the ENTER key

Recalculating r Ucl and r Lcl

Once subgroup data has been collected, the upper and lower control limits can be simultaneously recalculated.

To recalculate r Ucl and r Lcl:

▶ Highlight the r Ucl field

▶ Press the RECALC soft key

▶ Press the ENTER key

Warning limits

The Warning Per field is used to specify the upper and lower warning limits on the $\bar{x}$ and r SPC charts as a percentage of upper and lower control limits.

For example:

When the Warning Per = 66

and:	then:
$\bar{x}$ Ucl = 2.0000	$\bar{x}$ upper warning = 1.3200
$\bar{x}$ Lcl = -2.0000	$\bar{x}$ lower warning = -1.3200
r Ucl = 1.0000	r upper warning = 0.6600
r Lcl = 0.0000	r lower warning = 0.0000

To specify warning limits:

▶ Highlight the Warning Per. field
▶ Use the numeric keypad to enter the desired warning limits
▶ Press the ENTER key

Warnings and over limits are indicated on $\bar{x}$ and r SPC charts by color changes to yellow for warnings, and red for over limits. These colors can be changed in the Display setup screen.

Showing and hiding SPC graphs

The SPC graph for each dimension can be shown or hidden. Hiding SPC graphs for dimensions reduces system resource consumption and increases throughput speed.

To show SPC graphs:

▶ Highlight the Show Graph field
▶ Press the YES soft key
▶ Press the ENTER key

To hide SPC graphs:

▶ Highlight the Show Graph field
▶ Press the NO soft key
▶ Press the ENTER key

Header setup screen

The Header setup screen contains fields for creating header labels and user prompts for text that will be included on printed reports. Header information will be printed in text fields at the top of all reports oriented as shown on the Header setup screen.

Each header text field can be defined as a Label or a Prompt. Labels are created in the Header setup screen and printed on reports. Prompts are also created in the Header setup screen and printed on reports, but prompts elicit additional information from the user when the PRINT key is pressed. The user text response to the prompt will be printed next to the prompt on the report.

> Alpha characters can be entered in upper or lower case. Press the **ABC** soft key for upper case, or the **abc** soft key for lower case.
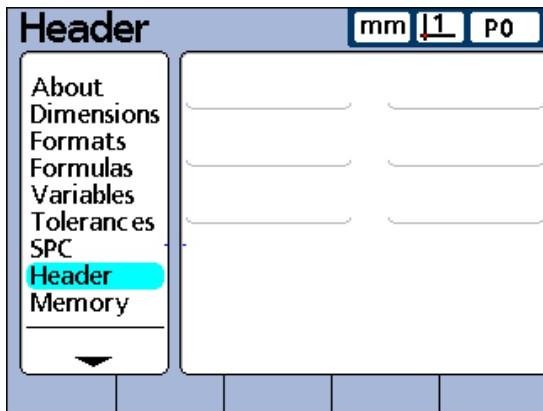
Header setup screen.

Labels

To create a label:

▶ Highlight the desired header field

▶ Press the LABEL soft key to define the field as a label

▶ Press the CHANGE soft key to display the Alpha Entry screen

▶ Use the arrow cursor keys to select the desired character

▶ Press the ENTER key to append the selected character to the message line. Use the SP character to include spaces.

▶ Use the numeric keypad to enter numbers

▶ Press the FINISH key to return to the Header setup screen

Prompts

To create a prompt:

▶ Highlight the desired header field

▶ Press the PROMPT soft key to define the field as a prompt

▶ Press the CHANGE soft key to display the Alpha Entry screen

▶ Use the arrow cursor keys to select the desired character

▶ Press the ENTER key to append the selected character to the message line. Use the SP character to include one space after the prompt, so that the prompt message is separated from the user's text response.

▶ Use the numeric keypad to enter numbers

▶ Press the FINISH key to return to the Header setup screen

Memory setup screen

The Memory setup screen contains fields that describe memory allocations and use for the total system and the current part.

Memory allocations are changed by the system when the user changes:

- The number of parts
- The number of measurements performed
- Formula complexity
- Parameters in the SPC setup screen

> → The Memory setup screen is provided only as a convenience for determining the memory usage in your system. The user cannot change memory allocations, beyond reducing the number of parts used or database records stored.

Memory setup screen.

S labels setup screen

The S Labels setup screen provides fields for labeling up to 16 system dimension formulas. Labels contain up to 3 alphanumeric characters. Alpha characters are in the range from A to Z and can be upper or lower case. Numeric characters are in the range from 0 to 9. The order of alpha and numeric characters in a label is defined by the user.

To specify and S Label:

- ▶ Highlight a system dimension field
- ▶ Press the LABEL soft key to display the Alpha Entry screen
- ▶ Enter the desired alphanumeric characters
- ▶ Press the FINISH key

S Labels setup screen.

S formulas setup screen

System formulas are created in the S Formulas setup screen and are used like the dimension formulas discussed earlier in this chapter. Unlike dimension formulas, System dimensions can be used by any part.

To create a system formula:

▶ Highlight the Label Name field
▶ Select a System Label using the INC or DEC soft key
▶ Press the ENTER key
▶ Enter the desired formula
▶ Press the FINISH key

> Formulas are explained in the Formulas section on page
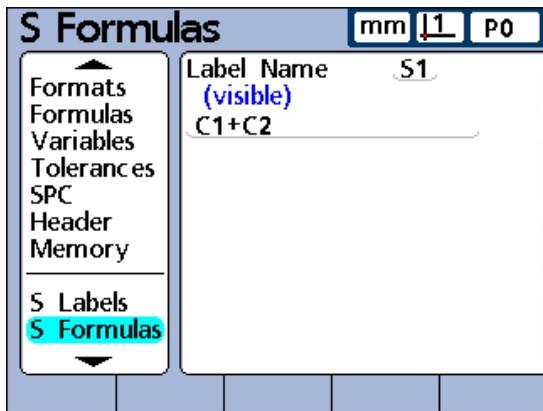
S Formulas setup screen.

Globals setup screen

The Globals setup screen shows the current state of global variables and is used like the Variables setup screen discussed earlier in this chapter. Global variables are used like variables except that, unlike variables, globals can be used by any part.

> Global variable functions are defined in the Formula setup screen. Formulas are explained in the Formulas section on page
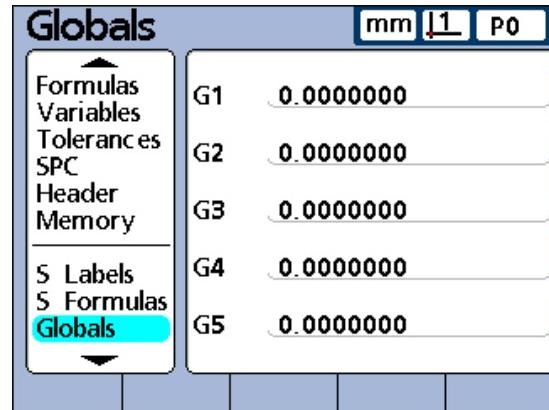
Globals setup screen.

Channels setup screen

The Channels setup screen contains fields for selecting, configuring and calibrating input channel devices. The input channel setup process is diagrammed here.

Specify the input channel number	▶	Select the input channel type	▶	Specify the channel parameters and calibrate if required
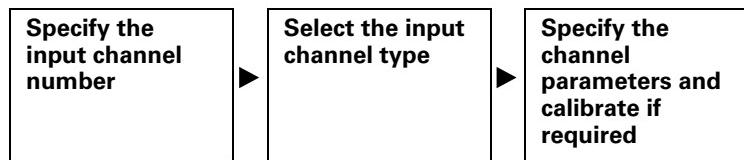
Specifying the input channel

To specify the input channel:

▶ Highlight the Channel field

▶ Press the DEC or INC soft key to specify the desired input channel

▶ Press the ENTER key
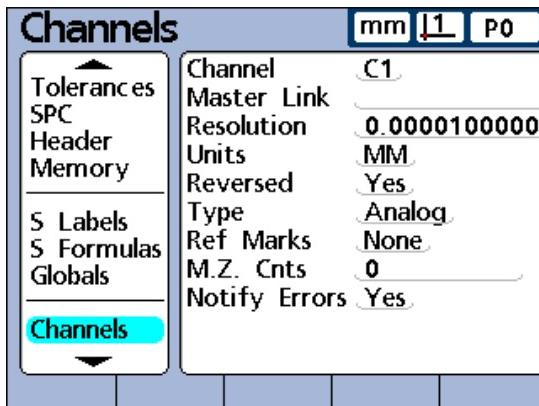
Channels setup screen.

Selecting the channel input type

Channel input devices are attached to standard interface connectors or to an RS-232 serial port on the rear of the ND 2100G. The number and type of channel inputs are specified when the ND 2100G is purchased, but might need to be specified again in the field.

Input type	Description
TTL	TTL square wave encoder
Analog	Sinusoidal analog encoder
D1311	RS-232 thermocouple
HBT	Analog input from half-bridge transducers
LVDT	Analog input from full-bridge transducers
Albion	RS-232 temperature compensation for gage materials
A2D	Analog input from a wide variety of analog to digital devices
A2E	Analog input from air gage devices
AEK	Analog input from AEK air gage devices
SerAxis	RS-232 Single probe input to primary or secondary RS-232 port
MTISer	Data byte inputs from single MTI probes
D5451	RS-232 serial thermocouple probe network
Orbit	RS-232 Solartron Orbit probe network
Marposs	RS-232 serial probe network
SonyMG	RS-232 Sony probe network
DMX	RS-232 multiplexer
MPLX	RS-232 multiplexer
Micro II	RS-232 interface
Endat Lin	EnDat linear encoder
Endat Rot	EnDat rotary encoder
AccuScan	RS-232 laser scanning interface

To select the channel input type:

▶ Highlight the Type field

▶ Press the LIST soft key to display the list of channel input types

▶ Use the UP and DOWN ARROW cursor keys to highlight the desired input channel type and press the ENTER key

Specifying input channel setup parameters

Input channel setup parameters change to support the selected input channel type. Some input devices share common parameters, and others require unique setup parameters. Setup parameters for all input types are described in this section, but only a portion of these setup parameters will apply to your system.

Master link probe balancing

The Master Link function masters two opposing probes for balanced probe measurements, as shown in this example of thickness measurement.

To balance two opposing probes:

▶ Confirm that the Reversed settings of the two probes are the same in the Channel setup screen for each channel. Change the setting of one if necessary.

▶ Confirm that Master setting in the Master setup screen is set to Min-Max. Change to Min-Max if necessary

▶ In the Channels setup screen for the first channel, highlight the Master Link field

▶ Press the + soft key

▶ Press the CHAN... soft key

▶ Enter the number of the second linked channel

▶ Press the OK soft key

▶ Place the desired artifact between the two probes

▶ Press the BALANCE... soft key

▶ You will then be instructed to move the artifact to one extreme of the measurement range. Move the artifact and press the ENTER key.

▶ You will then be instructed to move the artifact to the opposite extreme of the measurement range. Move the artifact and press the ENTER key.

▶ Balance scalars will be displayed. Press the OK soft key to save the balance scalars.

▶ Press the ENTER key to move to another field or the FINISH key to exit

> In the Channel setup screen of the linked (second) probe will now show the first probe number in the Master Link field. Do not change this field.
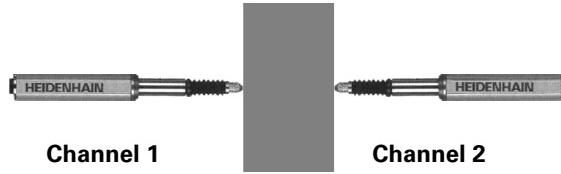
Channel 1   **Channel 2**

Material thickness is measured by two balanced probes. Place the artifact between the two probes.
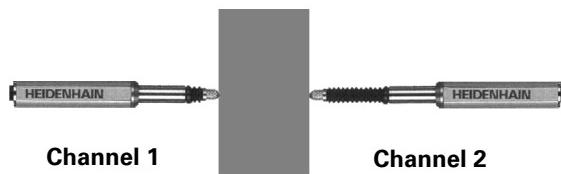
Channel 1   **Channel 2**

Move the artifact to one extreme of the measurement range.
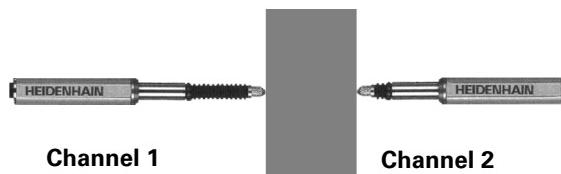
Channel 1   **Channel 2**

Move the artifact of the opposite extreme of the measurement range.

Setting the resolution for the linked channels

After balancing the master linked channels, the resolution of the first linked channel must be taught. The resultant resolution is applied to both linked channels.

To perform a resolution teach of the linked channels:

▶ Confirm that Master setting in the Master setup screen is set to Min-Max. Change to Min-Max if necessary.

▶ Highlight the Resolution field of the first linked channel

▶ Press the TEACH soft key

▶ Press the MIN soft key

▶ Put the Min standard piece between the two probes as shown on the right

▶ Use the numeric keypad to enter the value of the piece in the Min field of the first linked channel

▶ Press ENTER to teach the Min value

▶ Press YES to the prompt

▶ Press the MAX soft key

▶ Put the Max standard piece between the two probes as shown on the right

▶ Use the numeric keypad to enter the value of the piece in the Max field of the first linked channel

▶ Press ENTER to teach the Max value

▶ Press YES to the prompt

▶ The linked channels resolutions is now taught. Press FINISH to exit the resolution teach
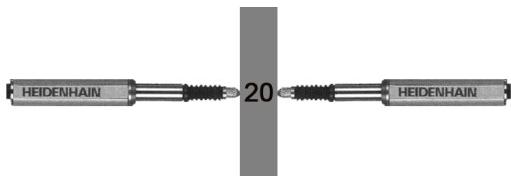
The Min is mastered.
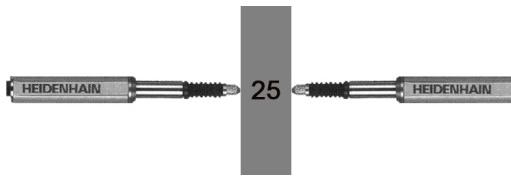
The Max is mastered.

Specifying channel input resolution

The resolution field defines the input resolution for encoder, transducer, thermocouple, RS-232 probe network and other channel inputs. Resolution values can either be manually entered if they are known, as in the case of encoders or taught, as in the case of transducers.

To specify a resolution:

▶ Highlight the Resolution field

▶ Use the numeric keypad to enter the resolution.

▶ Press the ENTER key

OR

Teach the resolution if the value is not known.

To perform a resolution teach:

▶ Confirm that Master setting in the Master setup screen is set to Min-Max. Change to Min-Max if necessary

▶ Highlight the Resolution field

▶ Press the TEACH soft key

▶ Press the MIN soft key

▶ Put the Min standard piece on the stage

▶ Use the numeric keypad to enter the value of the piece in the Min field

▶ Press ENTER to teach the Min value

▶ Press YES to the prompt

▶ Press the MAX soft key

▶ Put the Max standard piece

▶ Use the numeric keypad to enter the value of the piece in the Max field

▶ Press ENTER to teach the Max value

▶ Press YES to the prompt

▶ The channel resolution is now taught Press FINISH to exit the resolution teach

Transducers

Transducer gain must be calibrated before mastering the transducer resolution. The instructions for gain calibration are provided later in this chapter. After transducer gain is calibrated, LVDT and HBT transducer resolution is determined by performing a full calibration using the Master function. Refer to "Calibrating channels using the Master function" on page 43.

Specifying units of measure

The Units field is used to specify channel input units of measure. Displacement units of measure can be inches, millimeters, angular or numeric. Thermocouple units of measure can be Celsius, Fahrenheit or numeric.

To specify the units of measure:

▶ Press the LIST soft key. This displays a list of units of measure.
▶ Highlight the desired unit of measure
▶ Press the ENTER key to select the unit
▶ Press the ENTER key to advance to the next parameter

Reversing channel input polarity

The Reversed field is used to reverse the direction of all specified channel input counts, and will reverse the polarity of serial inputs.

Normally, displacement counts increase as the device is compressed or rotated clockwise. Serial input polarity can be reversed to suit the requirements of the application.

To reverse channel input polarity:

▶ Highlight the Reversed field
▶ Press the YES soft key
▶ Press the ENTER key

Specifying encoder reference marks

Encoder reference marks can be used to home the system when it is started. The ND 2100G can be configured to prompt the user to cross reference marks or to perform a hard stop machine zero prior to measurements.

To specify encoder reference marks:

▶ Highlight the Ref Marks field
▶ Press the LIST soft key to display a list of reference mark types
▶ Highlight the desired reference mark type
▶ Press the ENTER key to select the reference mark type
▶ Press the ENTER key to advance to the next parameter

> The Reference Marks setup parameter has no meaning when an RS-232 device is specified as the channel input.

When Manual is selected, the operator will be prompted when powering the system to move to the desired zero point and press the ENTER key. When Ref, Abs AC, or Abs HH is selected, the operator will be prompted to move the encoder to cross a reference mark.

> If a reference has been specified, a password is required to skip the reference initialization when power is applied to the system.

Changing the machine zero position

The M.Z.Cnts field can be used to specify an offset count value for repositioning machine zero.

To change the position of machine zero:

▶ Highlight the M.Z.Cnts field

▶ Use the numeric keypad to enter the required offset counts

▶ Cycle the ND 2100G power

▶ Cross reference marks when prompted during power-up

> The Machine Zero Count setup parameter has no meaning when an RS-232 device is specified as the channel input device.

Enabling scale error notification

The Notify Errors field is used to enable the reporting of scale errors for the specified channel on the DRO screen.

To enable scale error notification:

▶ Highlight the Notify Errors field

▶ Press the YES soft key

▶ Press the FINISH key

Calibrating LVDT and HBT transducer gain

The ND 2100G includes hardware and software for automatically calibrating the system to accommodate variations in transducer output level.

To calibrate LVDT and HBT transducer gain:

▶ Highlight the Gain field

▶ Press the TEACH soft key

▶ Follow instructions that appear on the ND 2100G screen for calibrating the system to accommodate the output level of the transducer connected to the selected channel

Centering (nulling) LVDT and HBT transducers

Transducer outputs are most linear in the central portion of their total range of movement. Each LVDT and HTB transducer must be positioned at the center of its range of movement (nulled) in the gage and against a nominal reference surface to provide the most accurate measurements. The bar graph at the bottom of the transducer Channel setup screens display the relative position of the transducer tips from one extreme of movement to the other and is used to null transducers as shown below.

Prior to conducting measurements the transducer gain must be calibrated as described on page 106, and then the transducer must be:

- Secured in the gage

- Positioned against the nominal reference surface

- Adjusted in the gage to null against the nominal reference surface

- Locked in place

Transducer fully extended.

Transducer nulled.

Transducer fully compressed.

When the transducer gain is calibrated and the transducer has been nulled against the nominal reference surface, the transducer resolution can be calibrated using the Master function and measurements can be conducted.

Transducer resolution is usually calibrated periodically on a schedule determined by the application and the measurement environment. Refer to Chapter 1: Operation for detailed instructions regarding the use of the Master function to calibrate transducer resolution.

Selecting an external RS-232 channel

RS-232 input networks include multiple channel inputs that are numbered to reflect the manufacturers' channel module identification system. These numbers must be entered into the Ext Num field of all Channels setup screens. Consult the documentation that accompanied the RS-232 network for a description of the module numbering system.

To specify a channel input number:

▶ Highlight the Ext Num field
▶ Use the numeric keypad to enter the manufacturers' channel module identification system number
▶ Press the ENTER key

Specifying an RS-232 input port

Multiple RS-232 serial ports are provided on ND 2100G units that include RS-232 input channels. In most instances the secondary port should be used for channel inputs. However, the primary port can be specified if desired.

To specify an RS-232 serial port for input channel connection:

▶ Highlight the Uart id field
▶ Press the DEC or INC soft key
▶ Press the FINISH key

> Communication with computers and other serial devices takes place over the primary serial port. Use of the primary serial port for the connection of serial input channel devices will make serial communication with other devices impossible.

EnDat 2.2 encoder interface

When EnDat 2.2 encoders are connected to channel inputs, Information, Diagnostics, Errors and Warnings information can be accessed through the Channels setup screen.

EnDat information	Description
Info	Displays the ID number, serial number, name, transfer cycles, signal periods, measuring steps, measuring length and maximum revolutions.
Diag	Shows the function reserves of the encoder: ■ Absolute track ■ Incremental track ■ Position value calculation
Error	Displays errors that can occur for that type of connected encoder, and shows if errors have occurred. A color-filled square after the respective error indicates the status: ■ **Gray** means that the error will **not** occur on the connected encoder ■ **Green** means that the error may occur on the connected encoder, and **no error** has occurred yet ■ **Red** signals that an error has occurred
Warn	Displays the warnings that may be generated by the connected encoder, and checks whether any of those warnings have been generated. A color-filled square after the respective warning indicates the status: ■ **Gray** means that the warning will **not** be generated by the connected encoder ■ **Green** means that the warning can be generated by the connected encoder, and **no warning** has been generated yet ■ **Red** signals that a warning has been generated
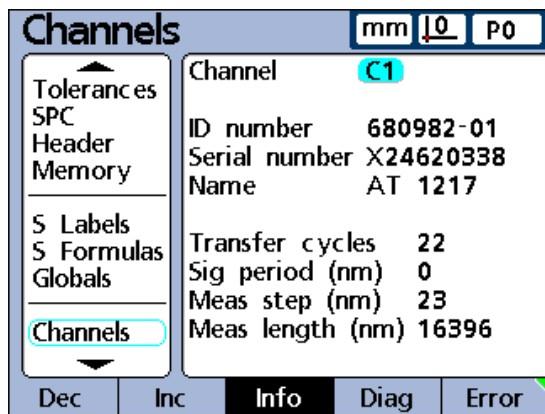
EnDat Info screen.
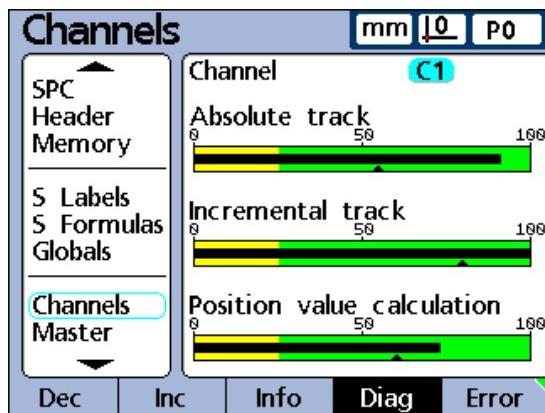
EnDat Diagnostics screen.

To access EnDat 2.2 encoder Information, Diagnostics and Errors:

▶ Highlight the Channel field

▶ Press the TEST soft key

▶ Press the INFO, DIAG or ERROR soft key

To access Warnings:

▶ Press the ERROR soft key again
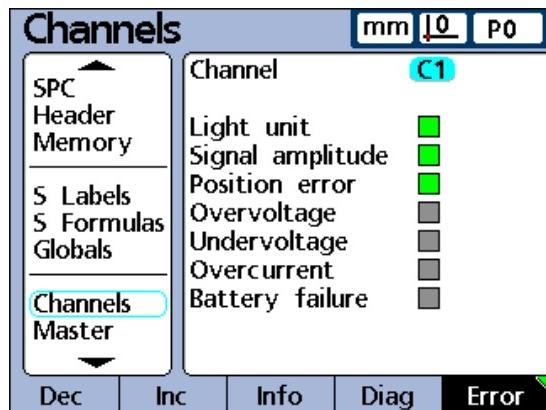
EnDat Errors screen.
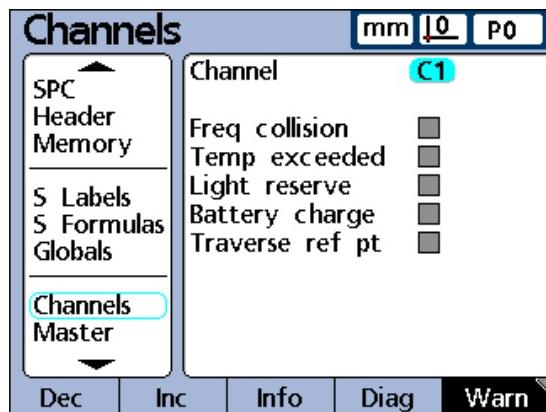
EnDat Warnings screen.

Master setup screen

The Master setup screen contains fields for setting up and calibrating encoders and transducers.

Specifying the number of calibration points

The calibration of the input encoders and transducers is performed using the Master function described on page 43. Calibrations can be based on a single data point, or on an average of up to 10 data points. Averaging data points is useful when calibrations are performed in the presence of vibration, surface irregularities or electrical noise.

To specify the number of points required:

▶ Highlight the Points Required field
▶ Use the numeric keypad to enter the number of required data points between 1 and 10
▶ Press the ENTER key

Selecting calibration type

Input channel calibrations are Min-Max or Mean.

Min-Max calibrations use data points on the low and high ends of the measurement range to define channel input resolution. LVDT, half-bridge transducers and inputs with initially undefined measurement resolutions require Min-Max calibrations.

Mean calibrations are used to preset input channels that are calibrated or have defined resolutions to specific values. Encoders, scales and other input devices with defined resolutions can be preset at any device state the user wishes using the Mean calibration type.

After Min-Max calibration, transducer input values can also be preset using the Mean calibration type. The channel input calibration process is discussed in detail in Chapter 1: Operation. Refer to "Calibrating channels using the Master function" on page 43.

Master setup screen.

Locking the calibration process if warnings occur

The calibration process can automatically be locked when a calibration fails and a warning is displayed. Once locked, the calibration process can only be completed by performing a new calibration that is successful or by entering the supervisor password to abort the calibration process.

To lock calibration when a warning is displayed:

▶ Highlight the Lock If Warning field
▶ Press the YES soft key
▶ Press the ENTER key

Specifying a calibration interval

The Master calibration screen can automatically be displayed at regular intervals to support a schedule of periodic input device calibrations. The Master screen will be displayed at the specified intervals unless a setup screen is being displayed to configure the ND 2100G.

To specify a calibration interval:

▶ Highlight the Do Every (hrs) field
▶ Use the numeric keypad to enter the amount of time in hours
▶ Press the ENTER key

> The user will be unable to skip a calibration without the supervisor password when the Lock If Warning field is set to Yes.

Using dynamic Min/Max values for calibration

Dynamic minimum and maximum measurements can be used in place of static artifact measurements for calibration when the calibrations must be performed in a gage system using rotary standard parts or rock step masters.

To specify the use of dynamic minimum and maximum values for calibration:

▶ Highlight the Use DMin/DMax field
▶ Press the YES soft key
▶ Press the ENTER key

When dynamic minimum or maximum measurements are used for calibration, the Actual value on the Master screen changes as a standard part is rotated until the minimum or maximum values are found. Once the minimum or maximum values are displayed, the user enters the value for the calibration and presses the ENTER key.

When Mean calibrations are performed, the calibration of the minimum value establishes a channel preset.

When Min-Max calibrations are performed, the minimum value establishes a preset and the combination of the minimum and maximum values is used to define channel resolution.
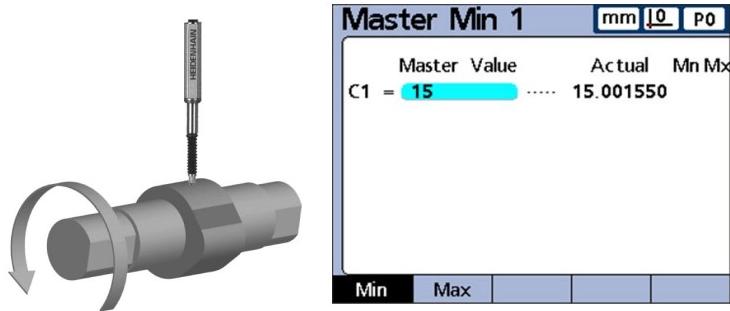
1.5 cm Dmin is measured and mastered as Min 1.
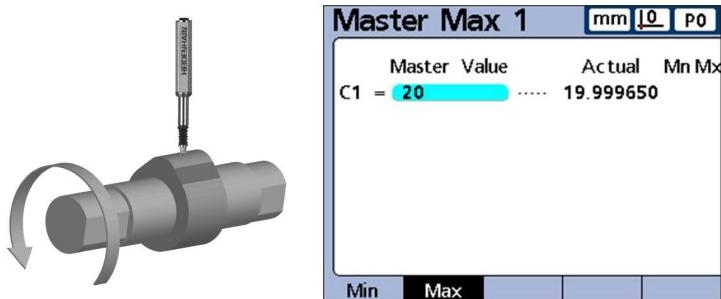
2.0 cm Dmax is measured and mastered as Max 1.

Specifying Min and Max calibration warnings

Periodic calibrations of input devices are sometimes performed on a regular schedule using the same calibration artifacts for each calibration. The Min and Max calibration warnings support these activities by validating each calibration. Warnings apply only to user-specified linear channels, not to angular or time oriented channels. Specify the channel by decrementing or incrementing to the desired channel number.

Calibrations are validated by comparing each new set of calibration values to the original calibration values. Significant differences between the new and original values indicate artifact errors, equipment malfunctions or measurement errors. The acceptable difference between the new and original calibration values is specified by entering the acceptable difference into the Min Warning and Max Warning fields.

During calibration, if new calibration values fall outside the acceptable range, the calibration is invalidated and a warning is displayed. When a new calibration is invalidated, the user can correct the problem and attempt another new calibration, accept the value as a preset or conduct measurements using the original (unchanged) calibration values.

To specify the acceptable range of new calibration values:

When Mean calibrations are performed, only the Min Warning value is required.

▶ Highlight the Min Warning field
▶ Enter the acceptable deviation from the original minimum master calibration value

When Min-Max calibrations are performed, Min and Max Warning values are required.

▶ Highlight the Max Warning field
▶ Enter the acceptable deviation from the original maximum master calibration value
▶ Press the ENTER key

> The Min/Max warnings will be applied to the next set of calibration values obtained using the Master function described in Chapter 1: Operation.

SLEC setup screen

The SLEC setup screen contains fields for configuring and enabling segmented linear error correction (SLEC), or linear error correction (LEC) for each input channel.

SLEC or LEC, which is right for my application?

Any channel input device can include slight nonlinearities over its measurement range. LEC compensates for nonlinearities by applying a single linear correction coefficient to the entire range of measurement. SLEC compensates for nonlinearities by applying multiple correction coefficients to individual nonlinear segments within the measurement range.

LEC is easy to set up, but does not provide correction for local nonlinearities that could be present over only small portions of the measurement range. SLEC correction requires a greater investment of time to set up, but results in more accurate measurements.

If an overall nonlinearity exists without significant local errors, LEC can be applied as a correction method. However, if input devices are found to have significant local nonlinearities, SLEC should be applied as a correction method.

SLEC setup screen.

> ➡️ SLEC and LEC require a repeatable machine zero.
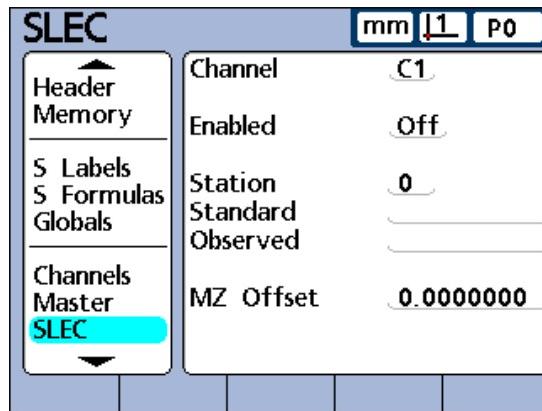
LEC (Linear error correction)

The LEC correction coefficient is created by the ND 2100G system using data provided by the user in the SLEC setup screen. The LEC setup data provided by the user consists of nominal and measured values of a standard at the two extreme ends of the entire measurement range.

This diagram below shows nominal (standard) values and measured (observed) values of a standard and shows that a small overall error exists across the entire measurement range.
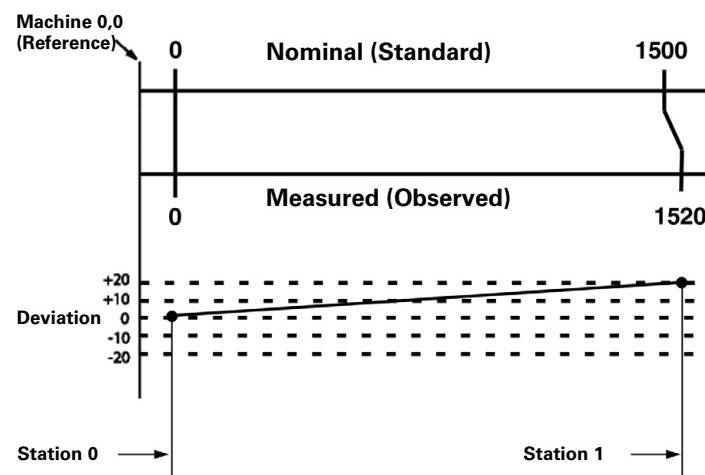
The standard and observed values at the two ends of the measurement range are entered as data for stations 0 and 1 in the SLEC setup screen. The standard and observed values at the beginning of the range are 0 because this end of the standard is the measurement reference. These zero values are entered into Station 0. The standard and observed values at the end of the range are 1500 and 1520 respectively in our example shown below, indicating a linearity error of 20 over the entire range of measurement. These values are entered into Station 1.

SLEC	mm ↓1 P0
▲	Channel C1
S Labels	Enabled Off
S Formulas	
Globals	Station 0
	Standard 0.0000000
Channels	Observed 0.0000000
Master	
SLEC	
Display	MZ Offset 0.3552400
Report	
▼	
Teach	

SLEC	mm ↓1 P0
▲	Channel C1
S Labels	Enabled Off
S Formulas	
Globals	Station 1
	Standard 1500.0000
Channels	Observed 1520.0000
Master	
SLEC	
Display	MZ Offset 0.3552400
Report	
▼	
Teach	

When the procedure is complete and setup data are entered, a correction coefficient will be calculated for the input device.

➡ The LEC setup procedure is a subset of steps required for SLEC setup and requires a repeatable machine zero and only the first and last station entries.

SLEC (Segmented linear error correction)

SLEC compensates for channel input nonlinearities by applying correction coefficients only to the segments that require them. These SLEC correction coefficients are created by the ND 2100G system using data provided by the user in the SLEC setup screen. The SLEC setup data provided by the user consists of nominal and measured values of a standard, or standards that cover the entire channel input range.

The measurements divide the channel input range into as many as 60 user defined segments. The diagram on the next page shows nominal (standard) values compared to measured (observed) values. The deviation (difference between standard and observed) is shown as a graph. Segments are defined here as any straight line on the graph, beginning with segment zero.

The standard and observed values at the end of each segment are entered as data into a station in the SLEC setup screen. For example, the standard and observed values at the end of segment 0 on the diagram are 400 and 400, and are entered in this screen for station 0.

1 Station number

2 Data
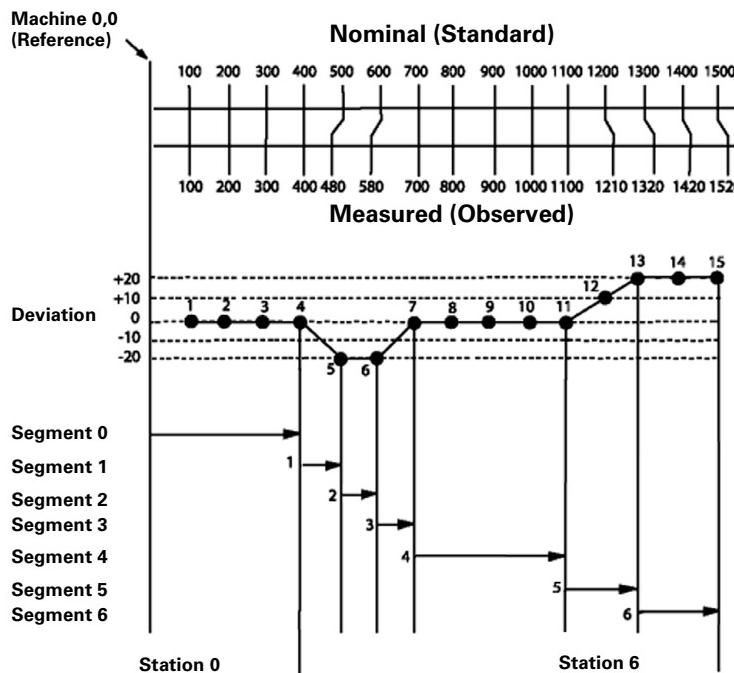
When the procedure is complete and setup data are entered, correction coefficients will be calculated for the input based on the standard and observed values at the end of each segment.

SLEC setup procedure

The SLEC setup procedure includes the following steps:

Clear all Datums	→	Cycle Power & Set Machine 0	→	Clear Old Values & Disable SLEC	→	Enter Machine 0 Offset	→	Enter New Station Values	→	Enable SLEC
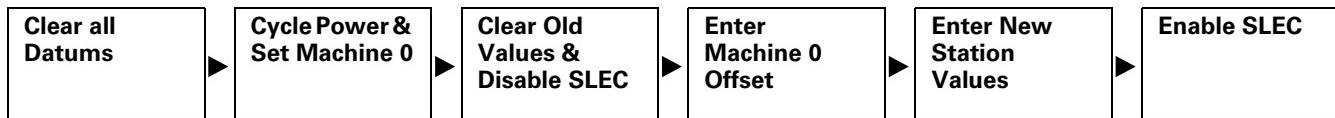
➡️ Make sure that all encoder channel resolutions and machine zero references are properly configured, and that any required channel Master operations have been completed prior to configuring the SLEC feature. Refer to the description of Channel setup on page 99, and to the description of the Master function in Chapter 1: Operation, on page 35.

Clear all datums

The following steps clear datums in preparation for SLEC standard measurements.

Clear all Datums	→	Cycle Power & Set Machine 0	→	Clear Old Values & Disable SLEC	→	Enter Machine 0 Offset	→	Enter New Station Values	→	Enable SLEC
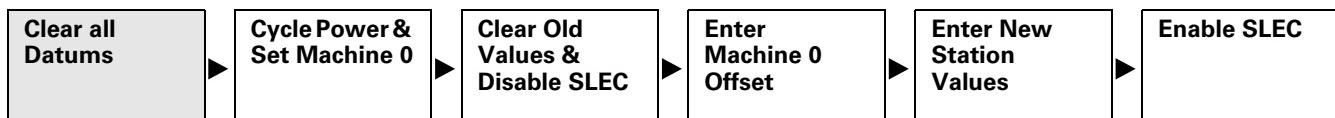
To clear all datums:

From the DRO screen.

▶ Press the MENU... soft key
▶ Press the DATUM... soft key
▶ Press the CLEAR soft key
▶ Press the YES soft key to confirm clearing all datums

Cycle power & set machine zero

The following steps cycle power to reestablish fresh machine zeros for all input channels.

Clear all Datums	▶	Cycle Power & Set Machine 0	▶	Clear Old Values & Disable SLEC	▶	Enter Machine 0 Offset	▶	Enter New Station Values	▶	Enable SLEC

To cycle power and set machine zeros:

▶ Turn the ND 2100G power switch off, wait for a few seconds and turn the power switch on again

▶ Press the FINISH or QUIT key to initiate the ND 2100G display

You will be prompted to move the encoder to cross reference marks or perform hard stop zeroing on all input channels.

> ➡ Reference marks must be specified in the Channels setup screen to establish a machine zero on startup.

▶ Perform machine zero operations on all channels

> ➡ If a hard stop zero is performed, the same stop will be required each time the ND 2100G is started.

Clear old values & disable SLEC

The following steps disable the SLEC feature to isolate the SLEC data fields during the data entry process, and clear old SLEC values.

Clear all Datums	▶	Cycle Power & Set Machine 0	▶	Clear Old Values & Disable SLEC	▶	Enter Machine 0 Offset	▶	Enter New Station Values	▶	Enable SLEC
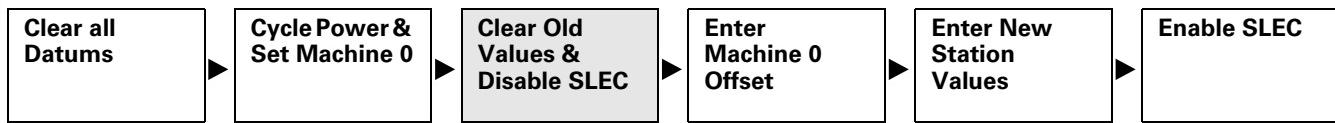
To clear old SLEC values:

▶ Navigate to the Supervisor setup screen

▶ Enter the supervisor password

▶ Unlock the Datuming and Clearing Data

▶ Navigate to the SLEC setup screen

▶ Highlight the Channel field

If this is the first time that SLEC compensation is being configured, or if new SLEC values are being created for all encoders, then SLEC for all channels must be disabled. Any existing SLEC values must also be cleared. However, if only a fraction of channels require new SLEC values, only those channels must be disabled and cleared of old values.

▶ Use the DEC or INC soft key to select a channel that will be configured

▶ Highlight the Enabled field

▶ Press the OFF soft key to disable SLEC for the selected channel

▶ Highlight the Station field

▶ Use the DEC or INC soft key if necessary to display Station 0

▶ If the Standard and Observed fields contain data, press the REMOVE soft key to clear the data. The old station 0 data will be replaced by data from station 1.

▶ Continue pressing the REMOVE soft key until the Standard and Observed fields are empty

▶ Highlight the MZ Offset field

▶ Use the numeric keypad to enter 0 into the MZ Offset field

▶ Repeat these steps for each encoder channel to be configured for SLEC

Enter machine zero offset

The following steps enter the offset count value from machine zero to the standard's zero.

Clear all Datums	Cycle Power & Set Machine 0	Clear Old Values & Disable SLEC	Enter Machine 0 Offset	Enter New Station Values	Enable SLEC
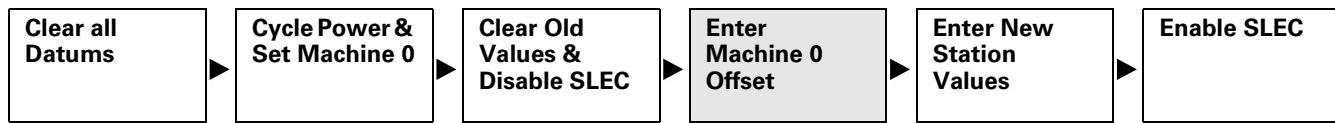
To enter the machine zero offset:

▶ Highlight the MZ Offset field of the channel being configured
▶ Position the Channel's probe at the standard's zero reference
▶ Press the TEACH soft key
▶ Press the ENTER key to enter the machine zero offset

Enter new station values

The following steps enter standard and observed values across the entire range of measurement.

Clear all Datums	▶	Cycle Power & Set Machine 0	▶	Clear Old Values & Disable SLEC	▶	Enter Machine 0 Offset	▶	Enter New Station Values	▶	Enable SLEC
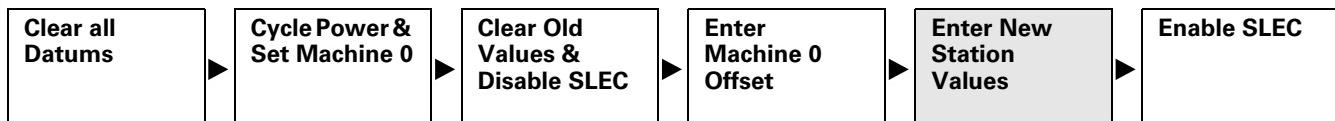
The Station 0 data is used as the reference for all subsequent SLEC segment measurements and is derived from the standard's zero reference. Station 0 Standard and Observed field data must be identical or entered as zeros to initiate the standard's reference position.

To enter new station values:

▶ Highlight the Standard field.

▶ Use the numeric keypad to enter 0

▶ Press the ENTER key. The Observed field is highlighted.

▶ Use the numeric keypad to enter 0

▶ Press the ENTER key

Now that the Station 0 reference data is entered into Standard and Observed fields, subsequent observed values can be measured and entered.

▶ Highlight the Station field

▶ Press the INC soft key to enter the next station number

▶ Highlight the Standard field

▶ Use the numeric keypad to enter the value marked on the standard part

▶ Press the ENTER key to enter the value. The Observed field is highlighted.

▶ Position the probe against the surface of the standard

▶ Press the TEACH soft key. The appropriate measured value will be displayed in the Observed field.

▶ Press the ENTER key to enter the value

▶ Repeat these steps to enter Standard and Observed values across the entire encoder range

Enable SLEC

When all station data for the encoder has been entered, the SLEC function must be enabled.

Clear all Datums	▶	Cycle Power & Set Machine 0	▶	Clear Old Values & Disable SLEC	▶	Enter Machine 0 Offset	▶	Enter New Station Values	▶	Enable SLEC
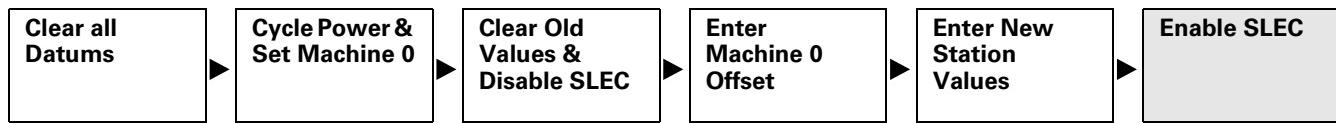
To enable SLEC:

▶ Highlight the Enabled field for any channel
▶ Press the ON soft key to enable SLEC or LEC for that channel

Display setup screen

The Display setup screen contains fields for configuring LCD display parameters.

Radix for numeric displays

The Radix field is used to specify the radix displayed in numeric fields.

To specify the radix:

▶ Highlight the Radix field
▶ Press the DECIMAL or COMMA soft key
▶ Press the ENTER key

Display mode for angles

The Current Angular field is used to specify the display mode for angles until system power is cycled. When power is cycled, the start-up angular setting will be used to define the display of angles. Current angular displays of measured angles can be set to decimal degrees (DD) or to degrees, minutes and seconds (DMS).

To specify Current Angular settings:

▶ Highlight the Current Angular field
▶ Press the DD or DMS soft key
▶ Press the ENTER key
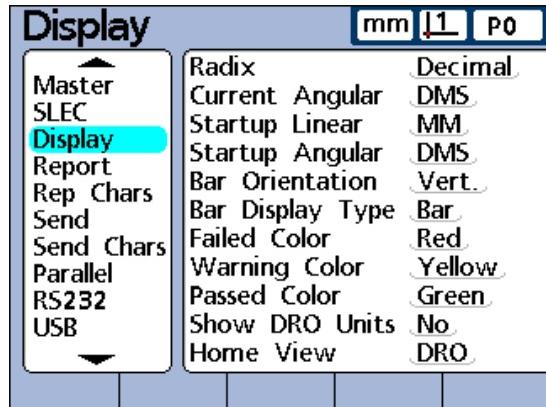
Display setup screen.

Startup angular and linear display modes

The Startup Angular and Startup Linear fields are used to specify the default display of angular and linear measurements when power is applied to the system. These display settings can be changed temporarily but will revert to the startup defaults unless the Last setting is selected. The Last setting can be selected to start the system using the last units that were active at shutdown.

Linear measurements can be displayed in English or metric units of measure. Angular measurements can be displayed in degrees, minutes and seconds or in decimal degrees.

To specify Startup Linear settings:

▶ Highlight the Startup Linear field

▶ Press the MM, INCH or LAST soft key

▶ Press the ENTER key

To specify Startup Angular settings:

▶ Highlight the Startup Angular field

▶ Press the DD, DMS or LAST soft key

▶ Press the ENTER key

Bar graph orientation

The Bar Orientation field is used to specify horizontal or vertical orientated dimension bar graphs.

To specify Bar Orientation settings:

▶ Highlight the Bar Orientation field

▶ Press the HORZ. or VERT. soft key

▶ Press the ENTER key

Bar graph or dial displays

The Bar Display Type field is used to specify a bar graph or dial for dimension current value readings from a single channel.

To specify Bar Display Type settings:

▶ Highlight the Bar Display Type Field

▶ Press the BAR or DIAL soft key

▶ Press the ENTER key

Colors that indicate measurement results

The Failed, Warning and Passed Color fields are used to specify colors used on DRO current value, graph, data and SPC screens to indicate measurement result status.

To specify Failed, Warning and Passed Color settings:

▶ Highlight the Failed Color, Warning Color or Passed Color field

▶ Press the soft key for the color you would like to specify. RED, YELLOW, GREEN, CYAN or MAGENTA.

▶ Press the ENTER key
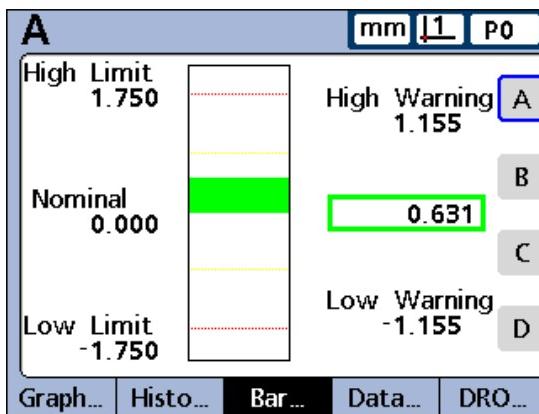
Vertical bar graph.
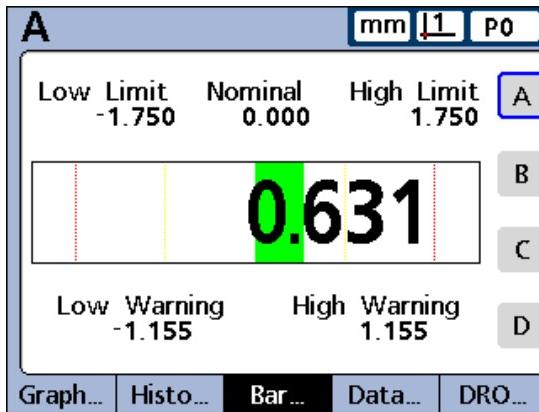
Horizontal bar graph.
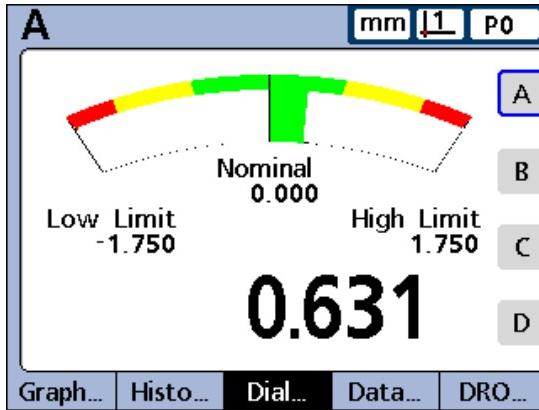
Dial graph.

Units of measure

Units of measure can be displayed near dimension labels on the DRO screen to increase clarity.

To show Units of measure in the DRO screen:

▶ Highlight the Show DRO Units field

▶ Press the YES soft key

▶ Press the ENTER key

Home screen

The Home View field is used to specify the first screen that will be displayed when power is applied to the ND 2100G. The Home View will also be displayed when the FINISH key is pressed from another view.

To specify the Home screen:

▶ Highlight the Home View field

▶ Press the LIST soft key

▶ Highlight the screen you would like to use as the Home screen

▶ Press the ENTER key

▶ Press the FINISH key
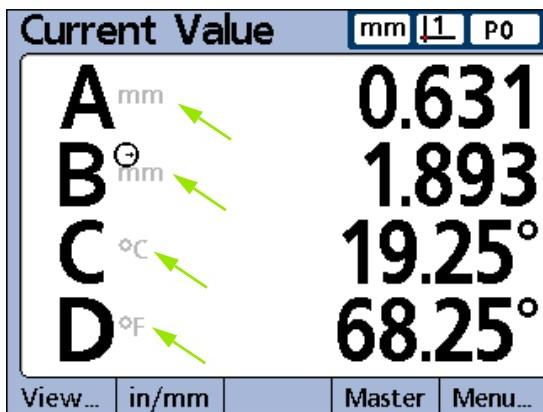
Units of measure.

Report setup screen

The Report setup screen contains fields for formatting and specifying the contents of printed reports.

Many fields provide the opportunity to turn report features on or off with selections of Yes or No.

Field	Description
Time Stamp	Date and time data was collected.
Divider Lines	Row and column lines.
Dimension Labels	Dimension labels at tops of columns.
Dimension Units	Units of measure printed with values.
Page Numbers	Report page numbers.

Report setup screen.

To enable these features:

▶ Highlight the desired field

▶ Press the YES soft key

▶ Press the ENTER key

Other selections should be made to adjust the print format to meet the unique requirements of individual reports.

Record number

Two numbers are displayed in the top-left corner of the data view screen under the time and date. The left number is the record ID (**1**) and the right number is the value of the dimension selected (**2**). In this example, the value of dimension A in record number 250 is 0.8013.

The record ID shows the relative position of the highlighted record within the total database of records. The most recent record appears at the top of the list, and is assigned the highest record ID number. When the number of records stored in the database equals the maximum records specified in the SPC setup screen, storing a new record replaces the oldest record. The record database is a pushdown queue.

1   Record number.

2   Dimension value within this record.

3   Dimension selected.

To specify Record number settings:

▶ Highlight the Record number field

▶ Press the NO soft key to omit record ID numbers from reports, the YES soft key to include the absolute ID number or the RELATIVE soft key to include the relative ID number

▶ Press the ENTER key

Lines per page

Horizontal divider lines and lines of text are considered lines.

To specify Lines Per Page:

▶ Highlight the Lines Per Page field

▶ Use the numeric keypad to enter the desired number of report lines

▶ Press the ENTER key

Columns per page

Only vertical columns of text are considered columns. The example report shown earlier contains 6 columns of text.

To specify the columns per page:

▶ Highlight the Columns Per Page field
▶ Use the numeric keypad to enter the desired number of report columns
▶ Press the ENTER key

Type of records to be printed

The records printed on a report can include a range specified by the user, records not yet printed (New), all records in the database or only the selected records.

Type	Description
Range	The user will be prompted to specify the number of records to print.
New	Only records that have not yet been printed will be printed.
All	All records in the database will be printed.
Selected	The highlighted record will be printed.
Prompt	The user will be prompted to select records to be printed.

To specify the records to be printed:

▶ Highlight the Recs To Print field
▶ Press the soft key for the type of records to be printed
▶ Press the ENTER key

Report characters setup screen

Report data can include ASCII codes such as Carriage Return, Line Feed and others to control printer functions and determine print formatting based on the unique requirements of specific printers. Multiple ASCII codes can be included in a single field when separated by spaces.

Field	Description
Pre Line	Before lines of text.
Post Line	After lines of text.
Pre Form	Before the form.
Post Form	After the form.
+Dim	After each dimension value.
+Unt	After each unit of measure.

To specify ASCII codes:

▶ Highlight one of the Rep Chars parameter fields

▶ Use the numeric keypad to enter the desired ASCII code

▶ Press the ENTER key to advance to the next parameter

▶ Repeat these steps until all desired ASCII codes have been entered

▶ Press the FINISH key

➡ To enter a space, use the DECIMAL POINT key on the numeric keypad.

➡ Refer to ASCII code table on next page.

Report characters setup screen.

ASCII codes:

Code	Character	Code	Character	Code	Character	Code	Character	Code	Character
8	Backspace	31	US	54	6	77	M	100	d
9	Horizontal tab	32	Space	55	7	78	N	101	e
10	Line feed	33	!	56	8	79	O	102	f
11	Vertical tab	34	"	57	9	80	P	103	g
12	Form feed	35	#	58	:	81	Q	104	h
13	Carriage return	36	$	59	;	82	R	105	i
14	SO	37	%	60	<	83	S	106	j
15	SI	38	&	61	=	84	T	107	k
16	DIE	39	'	62	>	85	U	108	l
17	DC1	40	(	63	?	86	V	109	m
18	DC2	41	)	64	@	87	W	110	n
19	DC3	42	*	65	A	88	X	111	o
20	DC4	43	+	66	B	89	Y	112	p
21	NAK	44	,	67	C	90	Z	113	q
22	SYN	45	-	68	D	91	[	114	r
23	ETB	46	.	69	E	92	\	115	s
24	CAN	47	/	70	F	93	]	116	t
25	EM	48	0	71	G	94	^	117	u
26	SUB	49	1	72	H	95	_	118	v
27	ESC	50	2	73	I	96	'	119	w
28	FS	51	3	74	J	97	a	120	x
29	GS	52	4	75	K	98	b	121	y
30	RS	53	5	76	L	99	c	122	z

Send setup screen

The Send setup screen contains fields for specifying the contents of record data files transmitted to computers. The Auto Send record feature can also be enabled in this screen.

Auto Send Rec

Record data can be transmitted automatically as each record is entered into the database.

To enable Auto Send Rec:

▶ Highlight the Auto Send Rec field

▶ Press the YES soft key

▶ Press the ENTER key

Record Number

To specify Record Number:

▶ Highlight the Record Number field

▶ Press the YES or RELATIVE soft key

▶ Press the ENTER key

> Refer to the discussion of record numbers for the Report setup screen on page 127 for more details regarding record number choices.

Record date, label and units of measure

Three fields provide the opportunity to include or omit record data with selections of Yes or No.

Field	Description
Time Stamp	Date and time data was collected.
Dimension Labels	Labels Dimension labels at tops of column.
Dimension Units	Units of measure printed with values.

To specify record date, label or units to include:

▶ Highlight the desired field

▶ Press the YES soft key

▶ Press the ENTER key

Send setup screen.

Record content

The records transmitted can include a range specified by the user; records not yet transmitted (New), all records in the database or only the selected record.

Type	Description
Range	The user will be prompted to specify the number of records to transmit.
New	Only records that have not yet been printed will be sent.
All	All records in the database will be transmitted.
Selected	The highlighted record will be transmitted.
Prompt	The user will be prompted to select records to be transmitted.

To specify the records to be sent:

▶ Highlight the Recs To Send field

▶ Press the soft key for the type of records to be sent

▶ Press the ENTER key

Min Dimen Size

Dimension data can be transmitted over the RS-232 connection with or without formatting placeholders.

Option	Description	Example
Largest	Sends data spaces for a sign character, 8 digits and a decimal point.	| | | | | |8|.|2|1|7|
Smallest	sends only the required 5 data spaces.	|8|.|2|1|7|

To specify Min Dimen size:

▶ Highlight the Min Dimen Size field

▶ Press the LARGEST or SMALLEST soft key

▶ Press the ENTER key

Send characters setup screen

Transmitted data can include ASCII codes such as Carriage Return (ASCII code 10), Line Feed (ASCII code 13) and others to provide formatting based on the requirements of the receiving computer software. Multiple ASCII codes can be included in a single field when separated by spaces.

Field	Description
-Send	Before record data.
+Send	After record data.
-Lbl	Before the form.
+Lbl	After the form
-Dim	After each dimension value.
+Dim	After each unit of measure.
-Unt	Before each unit of measure.
+Unt	After each unit of measure.

Send characters setup screen.

To specify ASCII codes:

▶ Highlight one of the Send Chars parameter fields

▶ Use the numeric keypad to enter the desired ASCII code

▶ Press the ENTER key to advance to the next parameter

▶ Repeat these steps until all desired ASCII codes have been entered

▶ Press the FINISH key

➡ Refer to the ASCII codes table on page 131.
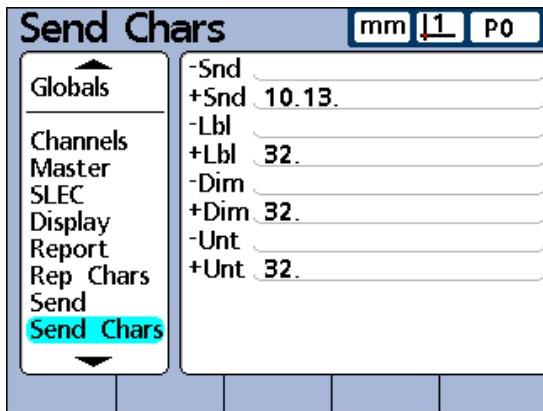
Parallel setup screen

The Parallel setup screen contains fields for enabling remote control of the ND 2100G and specifying a parallel port data debounce interval.

Remote control

Remote control of the ND 2100G is limited to measurements conducted under the supervision of an operator, and the ND 2100G will accept commands only while displaying the Home or View screens. To facilitate this remote control feature, a "receive ready" flag is set on Dout (1), parallel port pin 2 when the Home or a View screen is displayed. The remote computer or other controlling device can send commands upon detecting the receive ready flag. Commands sent to the ND 2100G when Dout (1) is logic level 0 will be ignored.

To enable the remote control feature:

▶ Highlight the Remote Control field

▶ Press the YES soft key

▶ Press the ENTER key

I/O Debounce interval

The parallel port is used as a general purpose I/O port. The source of logic levels presented to the parallel port pins can be solid state or hard contact switching devices. When hard contact switching devices are used, switching noise is often generated by contact bounce. The effects of switching noise are eliminated by validating the input logic levels for a short debounce time after the first level change occurs at the port.

To specify I/O Debounce:

▶ Highlight the I/O Debounce field

▶ Enter the debounce time in milliseconds

▶ Press the FINISH key
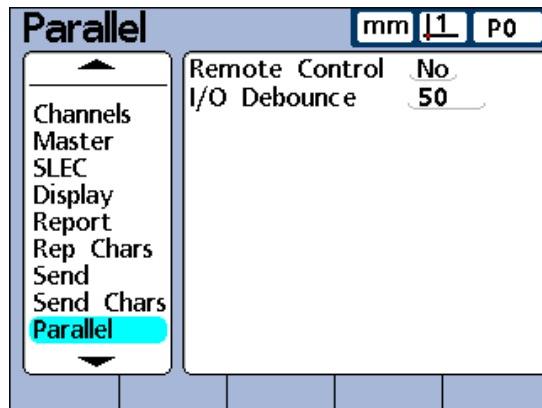
Parallel setup screen.

RS-232 setup screen

The RS-232 setup screen contains fields for specifying the RS-232 serial port settings for communication with a computer or RS-232 channel input device.

Uart Id

ND 2100G units that include a second RS-232 serial port for RS-232 input device connections must be configured to communicate with computers on either the primary or secondary port. Typically, computer communication takes place on the primary port, and RS-232 probe networks are attached to the secondary port. However, either port can be designated as the communication port.

To specify Uart Id:

▶ Highlight the Uart Id field

▶ Press the INC or DEC soft key to specify the desired port

▶ Press the ENTER key

Baud rate

The Baud field is used to specify the baud rate of serial data.

To specify Baud rate:

▶ Highlight the Baud field

▶ Press the DEC or INC soft key to decrease or increase the baud rate from 1200 to 115,200

▶ Press the ENTER key

Word length

The Word Len field is used to specify the number of bits contained in each data word.

To specify word length:

▶ Highlight the Word Len field

▶ Press the 7 or 8 soft key to specify the word length

▶ Press the ENTER key
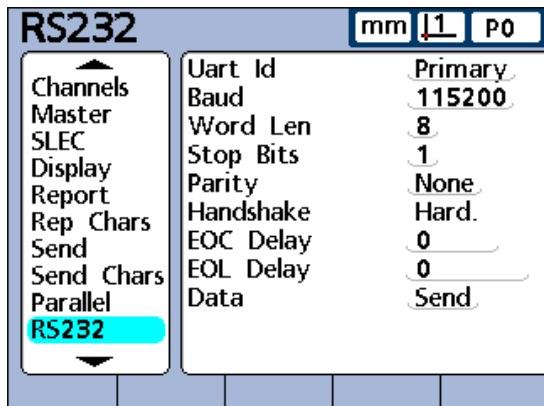
RS232 setup screen.

Stop bits

The Stop Bits field is used to specify the number of stop bits included after each data word.

To specify stop bits:

▶ Highlight the Stop Bits field

▶ Press the 1 or 2 soft key to specify the number of stop bits

▶ Press the ENTER key

Parity

The Parity field is used to specify odd or even parity for error checking, or to omit parity error checking.

To specify parity:

▶ Highlight the Parity field

▶ Press the NONE, ODD or EVEN soft key to specify parity error checking parameters

▶ Press the ENTER key

Handshaking

The Handshake field shows the type of synchronous signaling used by the system to prevent data collisions on the serial port. This is set to hardware and cannot be changed.

End of character (EOC) delay

The EOC delay field is used to specify the delay inserted after each character is transmitted. This delay can be increased or decreased to accommodate various serial devices.

To specify EOC delay:

▶ Highlight the EOC Delay field

▶ Use the numeric keypad to specify delays (in milliseconds) from 0 to 10 seconds between characters

▶ Press the ENTER key

Specifying end of line (EOL) delay

The EOL delay field is used to specify the delay inserted after each line is transmitted. This delay can be increased or decreased to accommodate various serial devices.

To specify EOL delay:

▶ Highlight the EOL Delay field
▶ Use the numeric keypad to specify delays (in milliseconds) from 0 to 10 seconds between lines
▶ Press the ENTER key

Serial port data type

Data can be sent to the serial port as a report formatted in the Report setup screen, or as record data formatted in the Send setup screen, or as both. The serial port can also be disabled for data transmission by selecting the NONE soft key.

To specify serial port data type:

▶ Highlight the Data field
▶ Press the soft key for the type of data to be sent
▶ Press the ENTER key

USB setup screen

The USB port can send data to a flash drive on the USB port or to a USB printer. The USB setup screen contains data and choice fields for configuring communication parameters of the USB port.

Data

Data can be sent to the USB port as a report formatted in the Report setup screen, or as record data formatted in the Send setup screen, or as both. The USB port can also be disabled for data transmission by selecting None.

To specify the Data:

▶ Highlight the data field

▶ Press the soft key for the type of data to be sent

▶ Press the ENTER key

Destination

Data can be sent through the USB port to be printed on a printer (HP2) or to be stored as a file (File) on a USB flash drive. Files stored on flash drives are named DataN.txt by the ND 2100G system, where N denotes the number of the data file.

To specify a data destination:

▶ Highlight the destination field

▶ Press the FILE or HP2 soft key

▶ Press the ENTER key
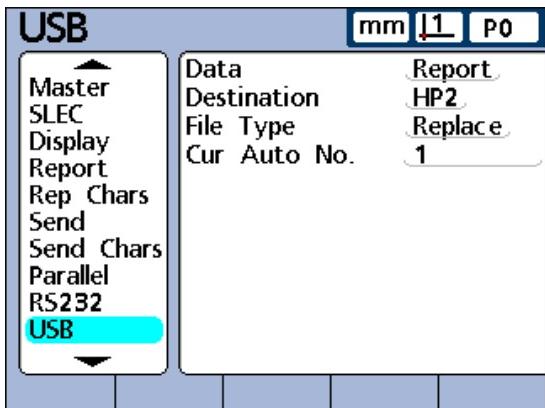
USB setup screen.

File type

The USB port data file type can be specified to replace existing files (of the same name) on the USB flash drive, append to the existing file or create new files that are auto numbered sequentially in ascending order (Data1.txt, Data2.txt.....DataN.txt).

To specify File Type:

▶ Highlight the File Type field

▶ Press the REPLACE, APPEND or AUTONO. soft key

▶ Press the ENTER key

Current auto (file) number

When the USB data file type is specified as AutoNo, the file number of the next file saved to the USB drive can be manually specified.

For example, entering a 2 into the Cur Auto No field will cause the next data file saved on the USB drive to be named Data2.txt. Any file that already exists on the USB flash drive with the same name will be overwritten.

To specify Current Auto Number:

▶ Highlight the Cur Auto No field

▶ Use the numeric keypad to enter the desired number of the next file

▶ Press the FINISH key

Hot Keys setup screen

The Hot Keys setup screen is used to map frequently used functions to front panel keys, remote keypad keys and foot switch keys. Hot keys can save time by eliminating the need to navigate through menus to initiate a function, or by making a function more accessible through a foot switch or remote keypad.
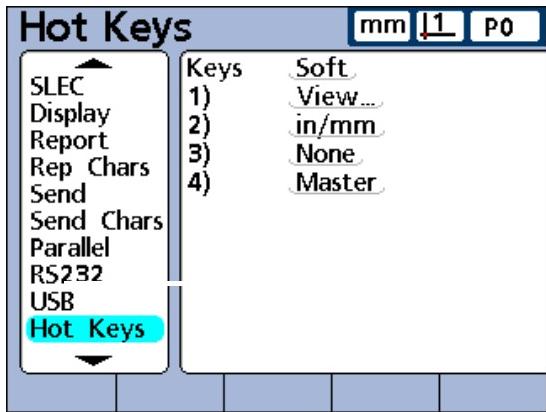
Hot Keys setup screen.

Front panel keys for hot key mapping

Front panel keys available for Hot Key mapping are shown here and included in menus of Hot Key types.

	Name	Descriptions
1	Wide keys	Both wide keys are available for Hot Key mapping. Hot Key functions assigned to wide keys can be invoked at any time.
2	Soft keys	The left 4 soft keys are available for Hot Key mapping. The right soft key under the LCD is used to access menus and is unavailable for Hot Key mapping. Functions assigned to soft keys can be invoked only when the home screen is displayed. At other times, soft key functions are permanently assigned by the system for menu, screen and function selection or dimension selection.
3	Unit keys	All unit keys except the decimal point and +/- keys are available for Hot Key mapping. Hot Key functions assigned to unit keys can be invoked at any time unless the system expects a numeric entry to complete a task.
4	Dimension keys	The 4 dimension keys at the right of the LCD are available for Hot Key mapping.
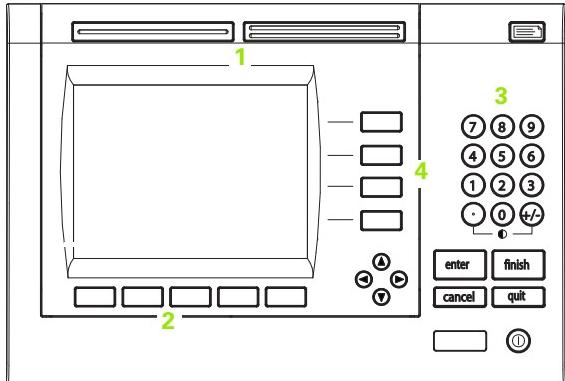
Remote switches and parallel port pins for hot key mapping

The foot switch, hand switch, remote keypad and parallel port input lines are also available for hot key mapping.

	Name	Descriptions
5	Remote keys	All numeric remote keys are available for Hot Key mapping. Hot Key functions assigned to numeric remote keys can be invoked at any time unless the system expects a numeric entry to complete a task.
6	Foot switch 1	The foot switch is used interchangeably with the hand switch. Both foot switch keys are available for Hot Key mapping. Hot Key functions assigned to foot switch keys can be invoked at any time.
7	Foot switch 2	
8	Hand switch 1	The hand switch is used interchangeably with the foot switch. Both hand switch keys are available for Hot Key mapping. Hot Key functions assigned to hand switch keys can be invoked at any time.
9	Hand switch 2	
10	Parallel port input pins	The parallel port is used as a general purpose I/O data port. The 5 input lines (Din 1 through Din 5) of the parallel port are available for hot key mapping.

Assigning hot key functions

The method used to assign hot key functions is identical for all hot key types.

Function categories:

Category	Function
None	No assignment will be made; this will not be a hot key.
Key	A front panel key function will be assigned by pressing one of the front panel keys.
Special	An ND 2100G system function will be assigned from the Special menu.
Func	A custom ND 2100G function will be assigned. User-defined functions can be assigned to all hot key types except dimensions (Dimens).

To assign hot key functions:

▶ Highlight the Keys field

▶ Press the LIST soft key. The available hot key types will be displayed.

▶ Use the arrow cursor keys to highlight a hot key type.

▶ Press the ENTER key

▶ Use the arrow cursor keys to select a specific key for hot key function assignment

▶ Select a function category from the soft keys at the bottom of the screen

▶ Follow instructions for selected function category outlined in the following pages.

Key

To assign a front panel key function as a hot key:

▶ Press the KEY soft key

▶ Press the desired front panel key to assign that front panel key's function to the specified hot key

Special

Special menu functions are slightly different between:

- Soft keys

- Dimension keys

- Unit, wide, foot keys, hand keys, remote keys and Din pins

The system functions mapped to dimension keys (Dimens) are limited to typical dimension activities, and apply only to the associated dimension. For example, when the Send function is mapped to the Dimension A soft key, only the current value of Dimension A is transmitted when the Dimension A soft key is pressed. The table on the next page shows what special functions can be assigned to different key types.

To assign an ND 2100G system function as a hot key:

▶ Press the SPECIAL soft key. The list of system hot key functions will be displayed

▶ Highlight the system function you wish to assign

▶ Press the ENTER key

System Function	Dimens	Din	Foot	Hand	Remote	Soft	Unit	Wide
Auto		■	■	■	■	■	■	■
Bar...		■	■	■	■	■	■	■
Clear		■	■	■	■	■	■	■
Clr All		■	■	■	■		■	■
Clr Part		■	■	■	■		■	■
Cycle		■	■	■	■	■	■	■
D0/D1		■	■	■	■	■	■	■
Data...						■		
DMS/DD		■	■	■	■	■	■	■
Dout		■	■	■	■	■	■	■
DRO		■	■	■	■	■	■	■
Fast3		■	■	■	■	■	■	■
Force		■	■	■	■	■	■	■
Graph...						■		
Histo...						■		
Hold	■	■	■	■	■	■	■	■
in/mm		■	■	■	■	■	■	■
Master		■	■	■	■	■	■	■
Part No.		■	■	■	■	■	■	■
Part?		■	■	■	■	■	■	■
Preset	■	■	■	■	■	■	■	■
Pressure		■	■	■	■	■	■	■
Rad/Dia		■	■	■	■	■	■	■
Recall		■	■	■	■	■	■	■
Relay		■	■	■	■	■	■	■
RsetDyn		■	■	■	■	■	■	■
r...						■		
Send		■	■	■	■	■	■	■
SendRec		■	■	■	■	■	■	■
View...		■	■	■	■	■	■	■
Zero		■	■	■	■	■	■	■
x...						■		

Special menu system functions descriptions

Auto

The Auto function toggles the Trip function on and off. Please refer to the discussion of the Trip function on page 212.

Bar...

The Bar... function selects the bar graph view of current values on the DRO screen.

Clear

Clears the incremental datums for all dimensions.

Clr all

Clears the ND 2100G database. No records will be retained for any parts.

Clr Part

Clears the ND 2100G database records for the specified part. No records for the specified part will be retained.

Cycle

Advances to the next part number. Part numbers are cycled in a continuous loop.

D0/D1

Toggles between the display of current values for the absolute datum (datum 0) and the incremental datum (datum 1).

Data...

The Data... function selects the data table view of stored records.

DMS/DD

Toggles between the current presentation of degrees/minutes/ seconds and decimal degrees for angular measurements.

Dout

Defines the logic state of one of the 12 parallel output pins to:

State	Description
Off	Logic 0 (0 volts)
On	Logic 1 (5 volts)
Toggle	Changes from one logic level to the other on a specified output pin.

Pin 13   Pin 1   Dout 8 7 6 5 4 3 2 1 9

Pin 25   Pin 14   Ground Reference 12 11 10 Dout
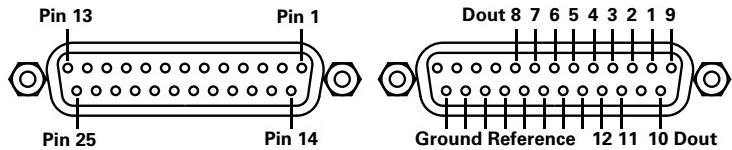
When the Dout function is selected, additional screens are provided for pin and logic level assignment.

➡ Logic ground is wired to pins 18 through 25.

DRO

The DRO function selects the DRO view of current values.

Fast3

The Fast3 function samples the channel 2 input each time the channel 1 input changes a specified sample increment. If the sampled value of channel 2 falls outside a specified range, all base channel (first 1, 4 or 8 channels) input values will be stored in a dedicated memory array, otherwise samples will not be stored.

This sampling process continues until one of the following occurs:

■ The user aborts the process by pressing the QUIT or CANCEL key

■ The user clears memory and restarts the process by pressing the ENTER key

■ The user successfully completes the process by pressing the FINISH key

■ The process is automatically completed after 50,000 sets of channel positions have been stored

Refer to "Fast3" on page 39 for more details.

Force

The Force function cycles through the display of units of force measurement as the hot key is repeatedly pressed. When the Force function is assigned to a soft key, the unit of force measurement will be displayed on the LCD above the soft key. When the Force function is assigned to something other than a soft key, the Show DRO Units function must be enabled in the Display setup screen to display the units of measure on the DRO.

Units of force measurement include:

■ N: Newtons

■ gf: Grams force

■ lbf: Pounds force

Graph...

The Graph... function selects the line graph view of stored records.

Histo...

The Histo... function selects the histogram graph view of stored records for display on the DRO screen.

Hold

This toggle function holds (freezes) or releases the current value displayed on the LCD for this dimension.

in/mm

Toggles between the display of dimension values between inches and mm.

Master

Displays the Master screen for calibrating or presetting inputs.

Part No.

The part number, selected by the user during Hot Key setup, becomes the current part when the key is pressed.

Part?

Displays a pop-up screen that allows the user to specify a new part number.

Preset

Presets this dimension's datum.

Pressure

The Pressure function cycles through the display of units of pressure measurement as the hot key is repeatedly pressed. When the Pressure function is assigned to a soft key, the unit of pressure measurement will be displayed on the LCD above the soft key. When the Pressure function is assigned to something other than a soft key, the Show DRO Units function must be enabled in the Display setup screen to display the units of measure on the DRO.

Units of pressure measurement include:

- ATM: Atmospheres
- Bar: Bars
- Pa: Pascals
- PSI: Pounds per square inch

Rad/Dia

Toggles between radius and diameter measurement types on the DRO screen if radius or diameter was specified in the Formats setup screen. Toggles between radius and diameter on single dimensions when assigned to a dimension key, or on all dimensions when assigned to other keys.

Recall

Recalls and applies this dimension's last used datum preset.

Relay

The output states of Relay 1 and Relay 2 can be assigned to hot keys. The output state of each relay is independent of the other, and can be the de-energized (0), or energized (1) or toggled (0/1).

The list of relay operations includes:

- R1 0: Relay 1 is de-energized (off, 0)
- R1 1: Relay 1 is energized (on, 1)
- R1 0/1: Relay 1 is toggled between states (on to off, or off to on)
- R2 0: Relay 2 is de-energized (off, 0)
- R2 1: Relay 2 is energized (on, 1)
- R2 0/1: Relay 2 is toggled between states (on to off, or off to on)
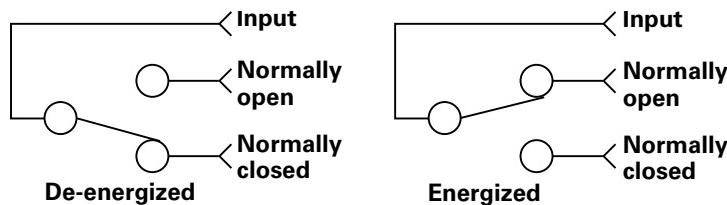
⚠ Be careful to limit relay contact voltage and current to the maximum ratings shown in Specifications on page 270. Exceeding the maximum ratings can damage the ND 2100G relay and void the product warranty.

RsetDyn

Resets the minimum or maximum values accumulated during dynamic measurements for this dimension.

r...

The r... function selects the line graph view of ranges of stored records for display on the screen.

Send

Transmits the current value displayed on the LCD for this dimension.

The Send function transmits data to a printer or a computer or both depending on parameters configured in the Parallel or RS-232 setup screens.

SendRec

The Send Rec function transmits the last (most recent) record, a range of records, or all records.

View...

Changes to the DRO and SPC data view for all dimensions.

Zero

Zeros the current datum for all dimensions.

$\bar{x}$...

The $\bar{x}$... function selects the line graph view of the mean of stored records for display on the DRO screen.

Func.

To map a hot key to a custom ND 2100G function:

▶ Press the FUNC. soft key
▶ Use the numeric keypad to enter the custom function number. The mapped custom function will be executed when the key is pressed.

Custom functions cannot be mapped to dimension keys.

> Custom functions are described in the Formulas section on page 238.

Clock setup screen

The Clock setup screen contains fields for setting and formatting displays of date and time shown on the LCD and printed on reports.

Setting the date and time

To set the date:

▶ Highlight the year field
▶ Use the numeric keypad to enter current data into the field
▶ Press the ENTER key
▶ Repeat these steps for the month and day fields

To set the time:

▶ Highlight the hours field
▶ Use the numeric keypad to enter current data into the field
▶ Press the ENTER key
▶ Repeat these steps for the minutes and seconds fields

Date format

The date format field specifies the format of the date shown on the LCD and printed on reports.

Date format soft keys and displays:

Date	Soft key	Date format display	
September 10, 2010	M/D/Y	**A**	**9-10-10**
	D/M/Y	**A**	**10-9-10**
	M.D.YY	**A**	**09.10.10**
	D.M.YY	**A**	**10.09.10**

To specify a date format:

▶ Highlight the Date Format field
▶ Press the desired date format soft key
▶ Press the ENTER key
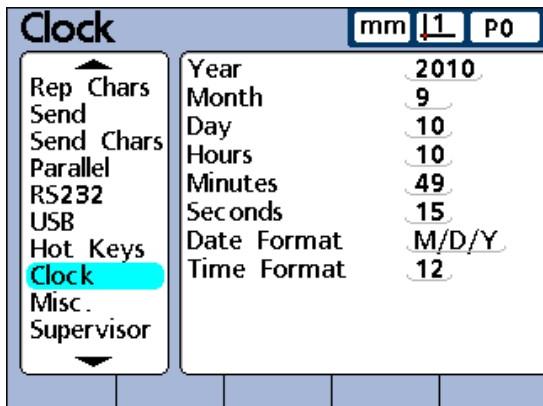
Clock setup screen.

Time format

The time format field specifies the format of the time shown on the LCD and printed on reports.

Time format soft keys and displays:

Time	Soft key	Time format display
12hr: 1:44:37pm 24hr: 13:44:37	12	**01.44.37**
	24	**13.44.37**
	12:	**01:44:37**
	24:	**13:44:37**

To specify a time format:

▶ Highlight the Time Format field

▶ Press the desired time format soft key

▶ Press the ENTER key

External edge setup screen (optional)

The External edge setup screen contains fields for specifying the touch probe parameters for optional edge detection functions.

Edge input

The External edge options are provided for one or two touch probes. The setup parameters are identical for all touch probes.

External edge probe timing

Probe and debounce delays can be included to limit probe input rate and provide immunity to noise. The impact of probe delay and debounce values is shown in this diagram.

Ext. Edge setup screen, single touch probe.

Ext. Edge setup screen, double touch probe.
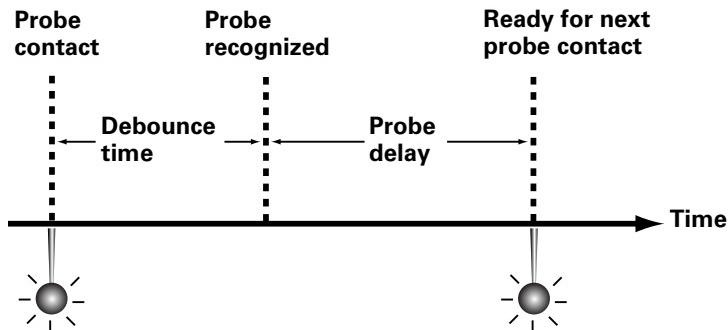
Probe delay

The Probe Delay field is used to limit the probe input rate. Enter the delay between valid probe hits into the Probe Delay field in milliseconds.

To specify probe delay:

▶ Highlight the Probe Delay field
▶ Use the numeric keypad to enter a probe delay in millisecond
▶ Press the ENTER key

Debounce time

The effects of electrical noise caused by mechanical switch contact bounce can be eliminated by specifying a settling time in milliseconds. Enter the desired time into the Debounce field in milliseconds.

To specify Debounce time:

▶ Highlight the Debounce field
▶ Use the numeric keypad to enter a debounce time in milliseconds
▶ Press the ENTER key

Edge Type

The direction of the touch probe signal that will be recognized as a valid probe contact is specified in the Edge Type field. Valid signals can be RISING, FALLING or BOTH (rising and falling). The external edge probe can also be DISABLED.

To specify Edge Type:

▶ Highlight the Edge Type field

▶ Press the soft key that specifies the edge type

▶ Press the ENTER key

Direction factor

The ND 2100G continuously monitors the direction of probe motion to insure that probe tip compensation is applied to the correct side of the probe. When the probe direction changes, a minimum number of counts in the new direction must be accumulated to verify that the direction change is valid.

Probe direction errors occur when probe tip compensation is applied to the wrong side of the probe tip. The ND 2100G prevents probe direction errors by monitoring the direction of probe movement and applying compensation to the leading side of the probe tip center. The ND 2100G then confirms probe direction changes by accumulating a minimum number of counts in the new direction before changing probe tip compensation. This minimum number of counts creates a zone around the tip referred to as the direction factor, and can be changed to accommodate different CNC hardware and application requirements.

Probe direction errors are usually caused by mechanical vibration or incorrect probing technique. The direction factor can be adjusted to minimize or eliminate both types of error.

Probe vibration

Direction errors are generated when the direction factor is smaller than the number of counts generated by mechanical vibration. Set the direction factor to a count value higher than probe vibration to eliminate errors due to typical probe vibration.

Direction factor lower than vibration causes errors.

Direction factor higher than vibration eliminates errors.

Probing technique

Direction errors are generated when probing paths are so close to part surfaces that direction changes cannot be verified. The examples that follow illustrate incorrect and then correct probing paths for the verification of horizontal direction changes.
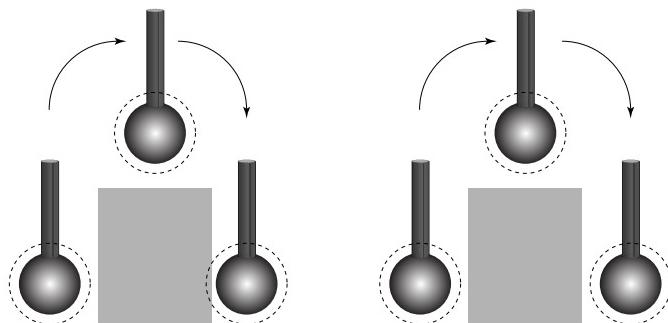
Incorrect probing technique.The probe is lowered too close to the part surface, detection of probe direction change is impossible.

Correct probing technique. The probe is lowered far enough from the part surface, detection of probe direction change is possible

To specify a probe direction factor:

▶ Highlight the Dir. Factor field

▶ Use the numeric keypad to enter the minimum number of counts in the new direction. This number should typically be 40 or greater.

▶ Press the ENTER key

Teaching a probe diameter

During measurements involving the touch probe, the ND 2100G subtracts the radius of the touch probe tip to determine true position of the probe. Since probe tip diameters can vary, the ND 2100G must determine the exact diameter from a test that utilizes a known standard.

To teach the ND 2100G the probe diameter:

▶ Highlight the Probe Diameter field

▶ Press the TEACH soft key. Instructions will be presented that describe the entire teach process.

▶ Follow the instructions given, while being careful to make orthogonal probe contacts with both sides of the standard
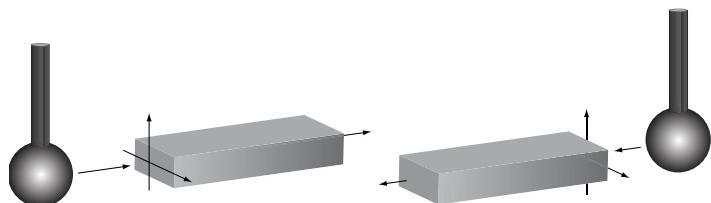
Be careful to make orthogonal probe contacts with both sides of the standard.

Misc. setup screen

The Misc setup screen contains fields for specifying keypad, LCD display, audio, SPC performance display, slew rate and screen saver parameters.

Key delay

The Key Delay field is used to adjust the rate at which front panel key presses will be accepted, and characters will be repeated when a front panel key is pressed and held down. As the delay value is increased, the rate of key entry and auto repeat decreases.

To specify Key Delay:

▶ Highlight the Key Delay field
▶ Use the numeric keypad to enter a key delay value
▶ Press the ENTER key

Speaker volume

The Volume field is used to adjust the loudness of ND 2100G speaker tones that signal key presses and alerts. Volume settings range from 0 to 10. A volume setting of 0 disables the audio output.

To specify Speaker Volume:

▶ Highlight the Speaker Volume field
▶ Use the numeric keypad to enter the desired volume
▶ Press the ENTER key

Data entry message time

The Data Entry Msg field is used to specify the duration of the display of the data entry confirmation message "Data has been added to the database" each time a value is entered. For example, when this value is 2, the message will be displayed for approximately 2 seconds. Durations range from 0 to 9999. When the value is 0, no message is displayed. When the value is very large, the message will be displayed until the user presses the Quit key, or the duration is allowed to complete.

To specify Data Entry Message time:

▶ Highlight the Data Entry Msg field
▶ Use the numeric keypad to enter the time to display a confirmation message
▶ Press the ENTER key
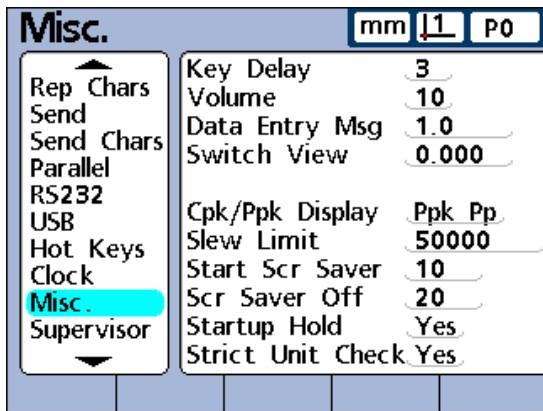
Misc. setup screen.

Switch view

Normally, the user presses soft keys to select the screens displayed on the LCD. However, the ND 2100G can be programmed to automatically change the DRO, bar or dial views to display a dimension in response to activity on the channel included in its formula. The Switch View field is used to specify the range of motion required on any channel input to switch DRO, bar or dial views to the associated dimension. When the Switch View field is zero, no switching occurs.

To specify Switch View:

▶ Highlight the Switch View field

▶ Use the numeric keypad to enter the range of motion required to switch the DRO view

▶ Press the ENTER key

Cpk/Ppk display

Cpk/Ppk Display is used to select process capability or process performance data to be displayed in the Data view screen for a single dimension.

To specify Cpk Cp or Ppk Pp data to be displayed:

▶ Highlight the Cpk/Ppk Display field

▶ Press the PPK PP or CPK CP soft key to select process or capability data

▶ Press the ENTER key

Slew limit

High input slew rates resulting from rapid input encoder motion can result in erroneous measurements. Erroneous measurements are avoided by displaying encoder error warnings when encoder values change at very high rates.

Enter the slew rate limit into the Slew Limit field in counts (increments of resolution) per second. For example, at a channel resolution of 0.001 mm, a slew rate limit of 50,000 will result in warning messages at encoder motion rates higher than 50 mm per second.

To specify Slew Limit:

▶ Highlight the Slew Limit field

▶ Use the numeric keypad to enter the slew limit

▶ Press the ENTER key

Start Scr saver

The Start Scr Saver field is used to specify the minutes of ND 2100G inactivity before the LCD screen saver is displayed. The screensaver is disabled when 9999 is entered into this field.

To specify Start Scr Saver:

▶ Highlight the Start Scr Save field

▶ Use the numeric keypad to enter the number of minutes of inactivity before the screen saver is activated

▶ Press the ENTER key

Scr Saver Off

The Screen Saver Off field is used to specify the range of motion in counts (increments of resolution) required on any channel to turn the screensaver off. For example, when Scr Saver off = 20, and the channel resolution is 0.001 mm, a movement of 0.020 mm will turn the screen saver off. When the Screen Saver Off field is zero, only pressing a front panel key will turn the screensaver off.

To specify Scr Saver Off:

▶ Highlight the Scr Saver Off field
▶ Use the numeric keypad to enter the range of motion required to deactivate the screen saver
▶ Press the ENTER key

Startup hold

The ND 2100G screen is displayed upon startup. Enter No into the Startup hold field to display the startup screen for a few seconds and then automatically display the home screen. Enter Yes to display the startup screen until the user presses the ENTER key.

To specify Startup Hold:

▶ Highlight the Startup Hold field
▶ Press the YES or NO soft key
▶ Press the ENTER key

Strict Unit Check

Enter Yes into the Strict Unit Check field to prevent calculations with mixed units of measure.

Example:

When Yes, the calculation:

15 mm+2.0 will not be allowed because of mixed units

When No, the calculation:

15 mm+2.0 = 17.0 Only numeric coefficients are used.

To specify Strict Unit Check:

▶ Highlight the Strict Unit Check field
▶ Press the YES or NO soft key
▶ Press the ENTER key

Supervisor setup screen

The Supervisor setup screen provides fields for entering the system password required to edit setup parameters and fields for locking or unlocking critical functions.

Password

To specify the system password:

▶ Highlight the Password field
▶ Use the numeric keypad to enter the system password
▶ Press the ENTER key

Unlocking and locking critical functions

Once the supervisor password is entered, most functions shown on this screen are locked or unlocked by highlighting the function and pressing the UNLOCKED or LOCKED soft key presented at the bottom of the LCD. Locking a function makes it unavailable for use. For example, when datuming is locked datums cannot be set, preset or cleared by the operator.

Part Settings

Part settings are found in the area above the first horizontal dividing line on the left side of the Setup menu screens and include the following setup screens:

◼ About

◼ Dimensions

◼ Formats

◼ Formulas

◼ Variables

◼ Tolerances

◼ SPC

◼ Header

◼ Memory

Datuming

Datuming functions include setting, presetting and clearing absolute and incremental datums.

Master Now

Master now unlocks or locks the Master function. Refer to "Calibrating channels using the Master function" on page 43.

Press the RD. ONLY soft key to allow the display of mastered values while prohibiting changes. Press the PASS soft key to restrict the Mastering function to those who enter the required supervisor password.

Supervisor setup screen.

Clearing Data

Measurement data can be removed from the ND 2100G database by the operator when this function is unlocked. Refer to "The datum menu functions" on page 37.

Control Keys

In normal operation, the user conducts measurements using the measurement control keys. However, when the ND 2100G is operated from a remote computer or PLC, it is often desirable to lock the control keys to eliminate the possibility that a user key operation will interfere with remotely controlled measurements.

Home Lock

Normally the user can designate the home view in the Display setup screen described earlier in this chapter. However, the home view can be locked by the supervisor to prevent changes.

Delete 1 Record

Single database records can normally be deleted from the View screen by the operator. Enter LOCK into the Delete 1 Record field to prevent single record deletions.

Lock Sys

Enter LOCK into the Lock Sys field to prevent changes to Global variables and system formulas that are used in formulas across a number of parts.

Clr Scale Records

Channel input malfunctions cause scale error messages that can be disabled by the user. Under some circumstances it can be undesirable to allow the user to disable these messages and continue operation. Enter LOCK into the Clr Scale Errors field to restrict disabling error messages to those with a valid supervisor password.

To unlock or lock a system function:

▶ Highlight the desired function field
▶ Press the UNLOCKED or LOCKED soft key
▶ Press the ENTER key

2.4 Formulas

Formulas define dimensions that are displayed on the LCD screen. Formulas can be created that make a dimension equal in value to a channel input, or that calculate a dimension from one or more channels using math, logic or other functions.

In this section, you'll learn the basics of creating formulas for the ND 2100G. You'll learn to create formulas that use math, logic and data evaluation functions to calculate dimensions, and to use advanced functions that control or automate measurements.

Introduction to formulas

Formulas use channel inputs and formula functions to define visible dimensions, hidden dimensions and custom ND 2100G functions. Formulas contain a dimension label at the top of a formula page, and arrange the defining channel functions, constants, and math, logic or control functions underneath.

The syntax of ND 2100G formulas is typical of algebraic equations generally, and is similar to the syntax used to define cell values in spread-sheet applications.

The examples below show simple formulas that define visible dimensions A, B, C and D using channel inputs C1, C2, C3 and C4:

Example	Description
A=C1	Dimension A is equal to the value of input channel 1
B=2*C2	Dimension B is equal to 2 times the value of input channel 2
C=C2+C3+C4	Dimension C is equal to the sum of the values of input channels 2, 3 and 4
D=C4	Dimension D is equal to the value of input channel 4

The channel inputs, Formula setup screens and resulting DRO screen for the examples are shown below:

C1=1.500 mm

C2=1.000 mm

C3=0.500 mm

C4=2.000 mm
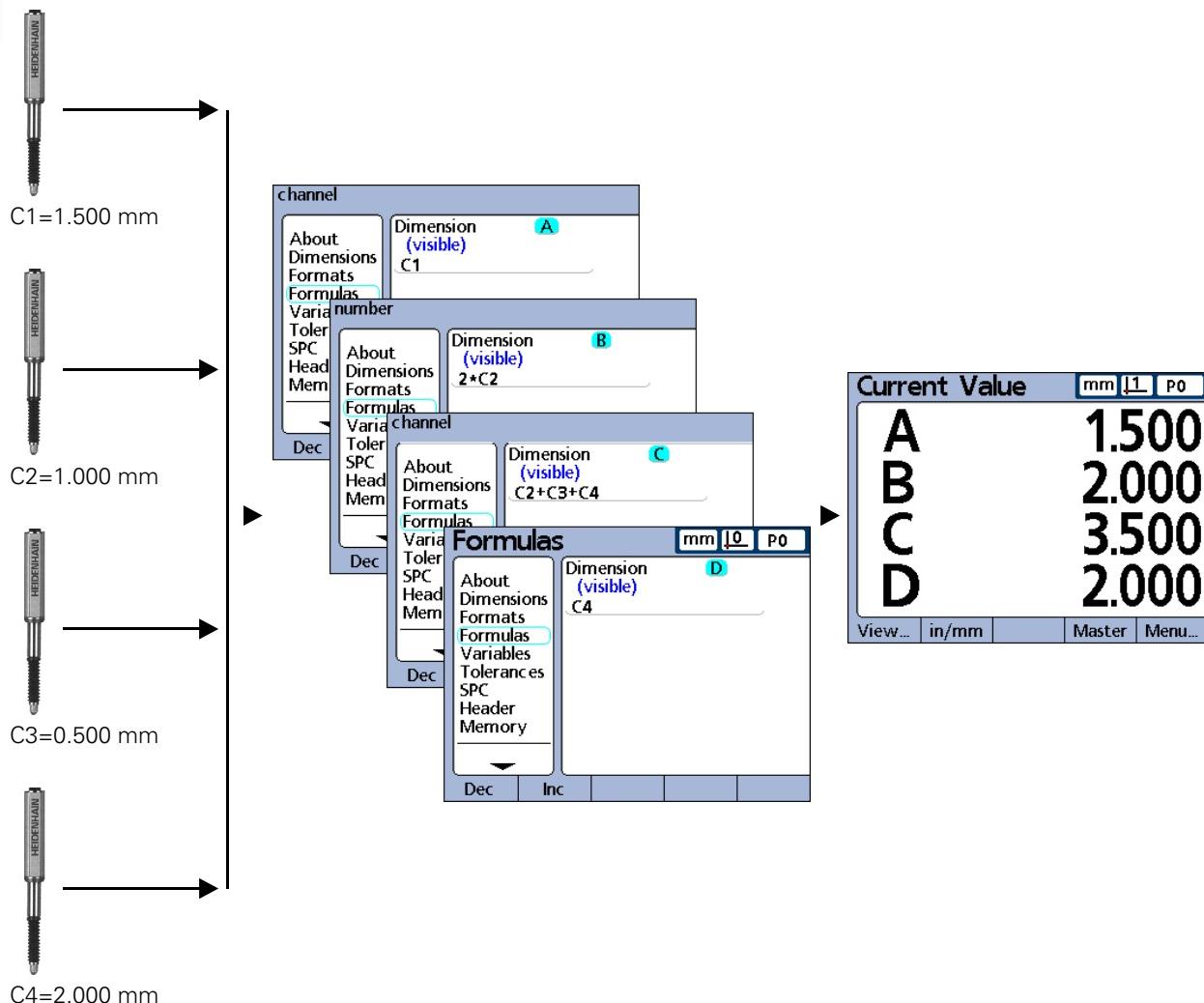
Channel inputs are processed by formulas to display dimensions.

How do formulas relate inputs to dimensions?

Formulas can be constructed that make dimensions equal to channel inputs, or that calculate dimensions from one or more channels using math, logic or other functions.

Formulas can be constructed by the user to display:

One dimension based on one channel input.
A=C1

One dimension based on multiple channel inputs.
A=C1+C2

Multiple dimensions based on one channel input.
A=C1
B=2*pi*C1

Multiple dimensions based on multiple channel inputs.
A=C1
B=C2
C=C1*C2

Visible or hidden dimensions?

Dimensions can be visible to display values or hidden to perform operations.

Visible dimensions

Visible dimensions are used with basic and advanced functions to calculate, display and store values in the ND 2100G database.

Example:

A = 2*pi*sqrt(B)

This formula uses visible dimension B in a formula with other functions to calculate and assign a value to visible dimension A, which is stored later in the ND 2100G database by pressing the ENTER key or executing a Trip function.

Hidden dimensions

Hidden dimensions are used with basic and advanced functions to perform operations.

Example:

H1 = if(fail(),Relay(1,1),Relay(1,0))

This formula uses the pass/fail state of all tolerance tests to control the state of output relay 1. Since values are not assigned to operations, no value will be stored in the ND 2100G database.

When are dimensions stored in the ND 2100G database?

Visible dimension values are displayed on the screen and are stored as records in the ND 2100G database when the ENTER key is pressed, or when a Trip function is executed.

Hidden dimensions are used to perform operations, make decisions or manipulate variables, and are not displayed on the screen or stored in the database.

What can formulas do?

Formulas can be constructed to produce a wide variety of results depending on channel input values, tolerance tests, parallel port conditions, time, temperature and other test and environmental conditions.

Formulas can:

■ Assign values to dimensions derived from channel inputs or other dimensions

■ Perform operations such as closing a relay contact, sending data to the parallel port, sending a message on the serial port or printing a report

■ Perform conditional tests of measurement results, tolerance test results, parallel port data, or environmental conditions and make decisions based on the results

■ Control the sequence of steps in a measurement process

■ Semi-automate a measurement process

■ Display messages and prompts for keyboard input

■ Define custom ND 2100G functions

When are formulas constructed or edited?

Formulas are constructed as the last step of the essential or minimum setup required to begin conducting measurements the first time the ND 2100G is used. The first steps of the initial setup are performed using the setup screens described earlier in this chapter and are diagrammed below:

Enter supervisor password	Configure input channels	Assign part & dimension labels	Configure display of data	Specify display resolution	Create dimension formulas
Supervisor setup screen	**Channels** setup screen	**Dimensions** setup screen	**Display** setup screen	**Formats** setup screen	**Formulas** setup screen
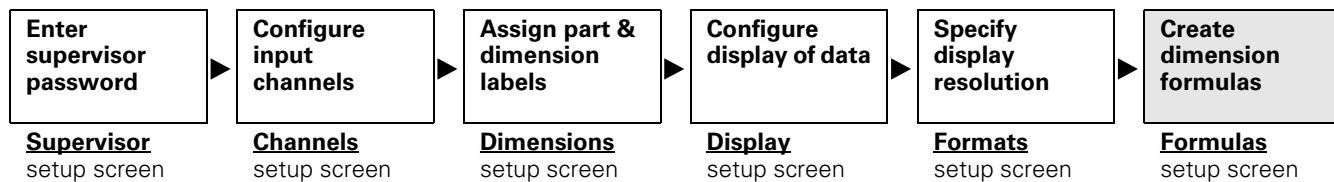
Formulas are constructed as the last step of initial setup.

How can formulas be recorded for safekeeping?

Formulas and all other ND 2100G settings can be stored on a USB drive as an .xml file from the Supervisor setup screen. Settings can also be stored on a USB drive as a text file by pressing the Print button when any setup screen is displayed. Please refer to the description of the Supervisor setup screen on page 161 for details.

Constructing and editing formulas

Formulas are constructed in the Formula setup screen.

To navigate to the Formula setup screen from the home screen:

▶ Press the MENU... soft key

▶ Press the SETUP soft key

▶ Repeatedly press the DOWN ARROW cursor key until Formulas is highlighted in the left portion of the screen

Formula setup screen

A default screen is shown prior to the construction of any formulas. Initially dimensions are visible, are labeled alphanumerically and are defined to display the channels in your system.

Disabling formulas temporarily for editing or troubleshooting

Normally, formulas are enabled and being evaluated by the system. However, formulas can be disabled temporarily for editing or troubleshooting.

To disable formulas:

▶ Press the TOP DIMENSION key at the right of the startup screen when power is applied to your system. The message "Disable formulas until you've had a chance to modify them?" will be displayed.

▶ Press the YES soft key. Formulas will be re-enabled upon exiting setup.

Selecting a dimension

To select a dimension:

▶ Navigate to the Formula setup screen

▶ Highlight the Dimension field

▶ Press the DEC or INC soft key to cycle through dimensions
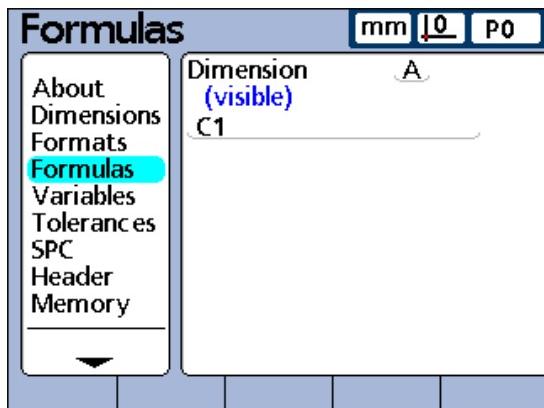
Formula setup screen prior to construction of a formula.

Entering dimension formula functions

To enter dimension formula functions:

▶ Press the DOWN ARROW cursor key to position the cursor on the formula line. A red cursor will appear at the extreme left of the formula line. This cursor indicates the insertion point for any new formula function.

▶ Move the cursor to the desired insertion point by pressing the LEFT or RIGHT ARROW cursor keys

▶ Repeatedly press a soft key to view the available options for that soft key

▶ Press a dimension key adjacent to the desired function to insert the function into the formula line

Inserting formula functions

Soft keys under the LCD screen control the display of channel and other functions required to construct formulas. Once displayed, formula functions are selected using the dimension keys at the right of the screen.

Repeatedly pressing any bottom soft key displays multiple sets of related functions for that soft key. For example, repeatedly pressing the OTHER... soft key (**1**) displays three sets of related functions (**2**) next to the dimension keys at the right of the screen.
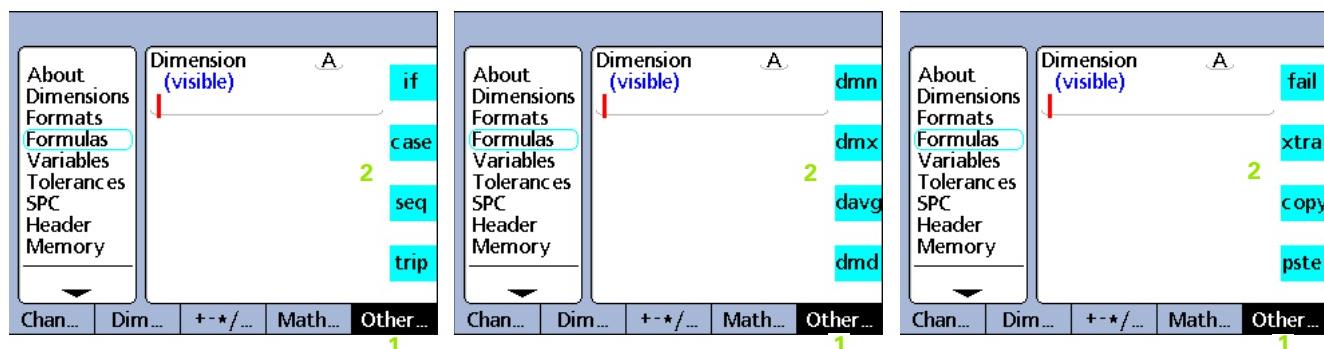
Pressing the OTHER... soft key repeatedly cycles through the OTHER functions, displayed on the right side of the screen next to the dimension keys.

Pressing a dimension key (**1**) at the right of a Formula setup screen inserts the formula function (**2**) associated with the key into a formula at the insertion point indicated by the vertical red cursor bar.
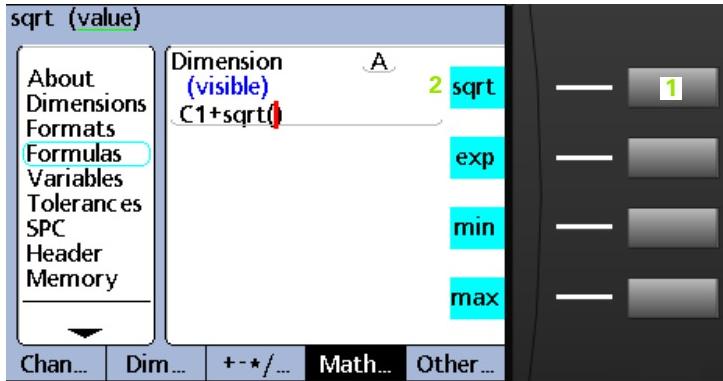
### Copying and Pasting formula functions

Formulas can be copied from one dimension and pasted into another.

To copy a formula:

▶ Use the arrow cursor keys to position the cursor in the formula line
▶ Repeatedly press the OTHER... soft key until the COPY (**1**) function is visible
▶ Press the COPY dimension key

To paste a formula:

▶ Use the arrow cursor keys to position the cursor in the formula line
▶ Press the OTHER... soft key until the PSTE (**2**) function is visible
▶ Press the PSTE dimension key
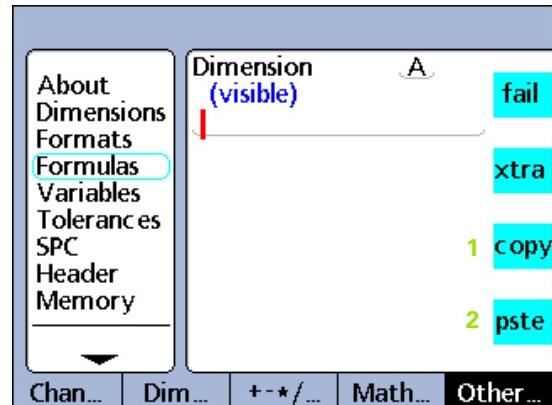
COPY and PASTE dimension keys.

Formula construction example

The exact steps required to construct or edit formulas are unique to each formula, and more generally to the measurements required for each part. It would be impossible to present a single set of instructions that adequately cover the topic. Instead, what follows is a generic guide to formula editing and construction in the form of an example. More specific instructions and examples regarding the use of formula constants, channel, dimension and other functions are provided later in this chapter.

The four steps required to construct a formula are:

| Select or assign part number	▶	Label dimensions	▶	Assign formula functions to dimensions	▶	Test formulas

The following example will use the default Formula setup screen to construct a formula that calculates the perimeter of a rectangular block from the measurement of two sides.

The general form of the formula necessary to calculate the perimeter of a rectangular block is:

■ Perimeter = 2 (side + end)

The specific formula that will be constructed in the Formula setup screen is:

■ P=2*(C1+C2)

End channel 2
C2

Side channel 1
C1
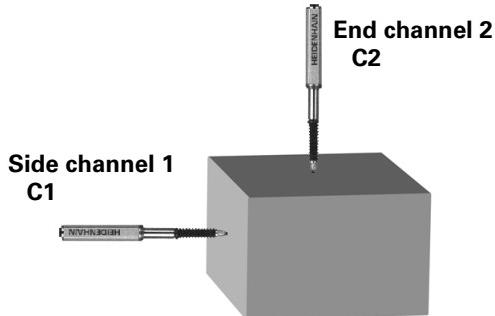
Select or assign a part number

Since separate dimension formulas can be created for each of up to 100 parts, begin by selecting the correct part.

Select or assign part number	▶	Label dimensions	▶	Assign formula functions to dimensions	▶	Test formulas
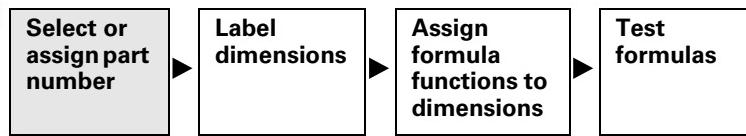
To select or assign a part number:

▶ From the home screen, press the MENU... soft key

▶ Press the SETUP soft key

▶ Press the DOWN ARROW cursor key to select and highlight the Dimensions setup screen

▶ Press the RIGHT ARROW cursor key to highlight the Part field

▶ Press the DEC or INC soft key to display the desired part number in the Part field or the NEW soft key to create a new part

Label the part's dimensions

Each dimension label should reflect the purpose of its formula.

Select or assign part number	▶	Label dimensions	▶	Assign formula functions to dimensions	▶	Test formulas

Relabel each dimension. Dimension labels can include up to 3 characters. Also give the part a name if desired. Part names can contain up to 8 alphanumeric characters.

In this example dimensions are labeled:

■ S = side, E = end and P = Perimeter

To label dimensions:

▶ While in the Dimensions setup screen, press the DOWN ARROW cursor key to highlight the first dimension field

▶ Press the LABEL soft key to display the Alpha Entry screen

▶ Replace each default dimension label by pressing the CANCEL key to erase the label, entering the desired alpha character(s) for the dimension's new label

▶ Press the FINISH key to return to the Dimensions screen

Since only three dimensions are used in this example, the fourth dimension is deleted. Refer to "Deleting formula elements" on page 175.

Original system designated dimension labels.


Dimensions relabeled to reflect purpose.

Assign formula functions to each dimension

Now that the correct part is selected, and the dimensions are labeled to reflect the measurement application, the dimension formulas must be constructed.

Select or assign part number	▶	Label dimensions	▶	Assign formula functions to dimensions	▶	Test formulas
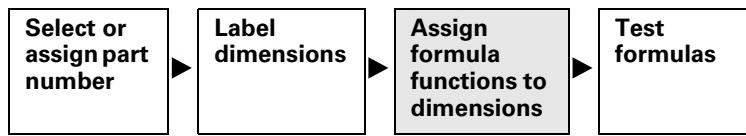
To assign formula functions:

▶ Navigate to the Formulas setup screen

▶ Press the RIGHT ARROW cursor key to highlight the Dimension field

The default formula for dimension S (C1) will be displayed.This formula already meets the requirement of our measurement application by displaying the side measurement as dimension S, so it will remain unchanged.

▶ Press the INC soft key to Display the formula for dimension E

This formula also meets the application requirement by defining dimension E as the value of channel 2 (C2), so it will also remain unchanged.

▶ Press the INC soft key to display the formula for dimension P. This formula will be changed to calculate the perimeter measurement.

▶ Press the DOWN ARROW cursor key to position the cursor in the formula line

▶ Press the RIGHT ARROW cursor key to position the cursor on the right side of the C3 channel function

▶ Press the CANCEL key to delete the C3 channel function

Now that the formula line for P is empty, the following new formula will be entered:

■ 2*(C1+C2)

▶ Press the numeric keypad 2 key

▶ Press the NONE soft key to make 2 a unitless constant

▶ Press the +-*/... soft key

▶ Press the * dimension key to insert the multiplication symbol into the formula

▶ Press the +-*/... soft key to display parentheses

▶ Press the (dimension key to insert the open parenthesis into the formula

▶ Press the CHAN... soft key to display channel functions

▶ Press the C1 dimension key to insert the Channel 1 function

▶ Press the +-*/... soft key repeatedly until the + arithmetic function is displayed

▶ Press the + dimension key to insert the plus sign

▶ Press the CHAN... soft key to display channel functions

▶ Press the C2 dimension key to insert the Channel 2 function

▶ Press the +-*/... soft key repeatedly until parentheses are displayed

▶ Press the) dimension key to insert the closed parenthesis

▶ Press the FINISH key twice to display the home screen

The formulas are now ready to test.

Test the formulas prior to use

Always test formulas thoroughly to confirm their correct operation before using them for inspection.

In this example, the ND 2100G encoders are positioned against the side and end of a rectangular block. The DRO screen displays a side dimension of 1.759 mm and an end dimension of 1.255 mm. The resulting perimeter is calculated to be 6.028 mm, which is correct and confirms that the formulas are ready to use.

E, ch 2

S, ch 1

P=2*(C1+C2)
6.028=2*(1.759+1.255)
Formulas are OK

Current Value	mm	1	P0
S			1.7590
E			1.2550
P			6.0280
View...	in/mm		Master	Menu...
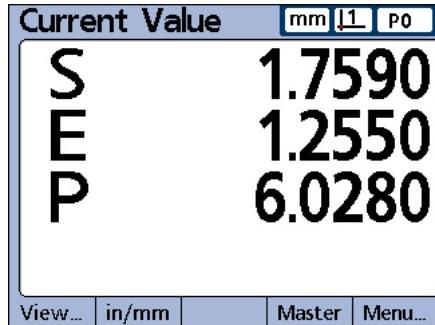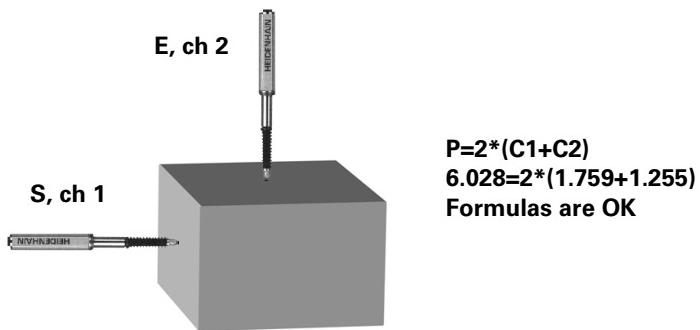
Long formulas

Complex formulas can be entered that require more than a single formula line. When formulas exceed a single line, the formula is continued on subsequent lines. It is rare that a single formula cannot be displayed on a single screen. However, if a formula cannot be displayed on a single screen, the formula can be scrolled using the UP or DOWN ARROW cursor keys.

Deleting formula elements

Unwanted formula elements can be deleted from the formula line.

To delete formula elements:

▶ Use the arrow cursor keys to place the cursor directly to the right of the formula element to be deleted in the formula line

▶ Press the CANCEL key. This deletes the function to the immediate left of the cursor.

▶ Repeat these steps until all desired formula elements are deleted

Formula functions

The remainder of this chapter describes formula functions in detail. Each description is accompanied by at least one example of use in a typical ND 2100G formula. Study these examples prior to constructing your formulas. Also, complete the essential setup steps shown below and discussed earlier to constructing formulas.

Enter supervisor password		Specify channel input type & resolution		Assign part number & dimension labels		Specify units of measure		Specify display resolution		Construct dimension formulas
Supervisor setup screen		**Channels** setup screen		**Dimensions** setup screen		**Display** setup screen		**Formats** setup screen		**Formulas** setup screen
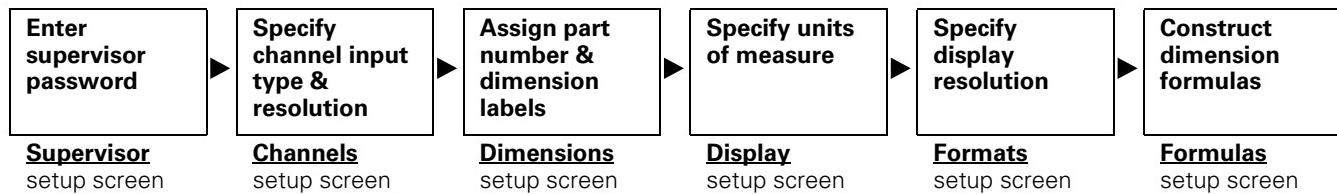
Initial ND 2100G setup must be completed prior to formula construction.

Basic and advanced formula functions

Basic and advanced formula functions are displayed and selected in the Formula setup screen by pressing combinations of soft keys located below the screen and dimension keys at the right of the screen. ND 2100G formula functions are shown under soft key column headings in the table below.

Basic and Advanced formula functions:

Chan...	Dim...	+ - * /...	Math...	Other...
C1	A	+	sqrt	if
C2	B	-	exp	case
C3	C	*	min	seq
C4	D	/	max	trip
ND 2100G can be ordered with 1, 4, 8, or 16 inputs	The number of dimensions is specified for each part in the Dimensions setup screen.	(	sin	dmn
		)	asin	dmx
		,	cos	davg
		;	acos	dmd
		>	tan	fail
		>= (≥)	atan	xtra
		<	avg	copy
		<= (≰)	md	paste
		== (=)	abs	
		!= (≠)	mod	
		&& (AND)	int	
		||(OR)	pi	
		-- (RANGE)		

xtra menu		
Ask	Global	Report
Beep	HwDmn	RsetDyn
ClrAllD	HwDmx	Scan
ClrData	HwLx	Send
ClrTrig	Lookup	SendMsg
DateStr	Loop	SendRec
Din	Master	SetColor
DinBin	MaxIndex	SetTrig
Display	MinIndex	Setup
Dout	OnEvent	Time
DoutBin	PartNo	TimeStr
FnCall	Preset	Var
FnDefine	Recall	Xlatch*
FnParam	Relay	
FnReturn	Remark	

*Xlatch is available in systems that include the external edge-detection option.

	= Basic function
	= Advanced function
	= Editing function

Basic formula functions

Basic functions calculate and display dimensions based on channel inputs, other dimensions, arithmetic operators, math functions and constants.

Chan...	Dim...	+ - * /...	Math...
C1	A	+	sqrt
C2	B	-	exp
C3	C	*	sin
C4	D	/	asin
ND 2100G can be ordered with 1, 4, 8, or 16 inputs	The number of dimensions is specified for each part in the Dimensions setup screen.	(	cos
		)	acos
			tan
			atan
			abs
			int
			pi

Typically, visible dimensions are used with basic functions to display values, and hidden dimensions are used with a combination of basic and advanced functions to perform operations.

Example:

A = 2*pi*sqrt(B)

This formula uses basic functions to assign a numeric value to visible dimension A. This value is stored in the ND 2100G database when the ENTER key is pressed or when a Trip function is executed.

Basic functions include:

■ Channel functions (C1...) include channel inputs in formulas

■ Dimension functions (D1,D2...H1,H2...S1,S2...) include other dimensions in formulas

■ Arithmetic operators (+ - * /) add, subtract, multiply or divide

■ Parentheses ( ) group terms within a formula

■ Square roots (sqrt) find the square roots

■ Exponents (exp) raise to a power

■ Trig functions (sin, cos, tan) find trigonometric values

■ Inverse trig functions (asin, acos, atan) find inverse trig values

■ Absolute value (abs) remove sign (polarity)

■ Integer (int) convert real numbers to whole numbers

■ Constants (Numbers and pi) include values that don't change in formulas

Channel functions

Channel function values are determined by the outputs of measurement devices attached to channel input connectors on the rear panel of the ND 2100G. These values can be offset, scaled or calibrated using the Master or SLEC/LEC error correction functions.

The Master function is available to operators using the front panel MASTER soft key, can be used in formulas and is used to offset or calibrate channel inputs. Error correction is only available to supervisors using the SLEC setup screen, and is used to compensate for transducer or encoder nonlinearities.

Channel functions can be assigned units of measure for linear, angular or temperature values, or can be numeric (no unit of measure). Units of measure can be assigned by supervisors using the Channels setup screen.

Channel functions used as variables in formulas can be:

■ Direct from the channel inputs

■ Level adjusted and calibrated by the Master function or error correction

■ Given linear, angular or temperature units of measure

| Channel Input | ▶ | Master Function | ▶ | Error Correction (SLEC, LEC) | ▶ | Units of Measure | ▶ | Channel function |
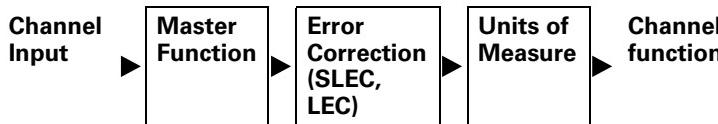
Channel inputs are processed before becoming channel functions that are used in formulas.

Insert channel functions into formulas to include channel values in dimensions.

To insert a channel into a formula:

▶ Press the CHAN... soft key

▶ Press the dimension key for the channel you would like to insert

Channel values can be assigned directly by making a dimension equal to a channel function or can be used in calculations as shown below:

Example 1: Directly assigned.

A=**C1**

Example 2: Used in Calculation.

A = (Pi*(C1exp2))/4

Where:

A = Area

C1 = Diameter of a circle
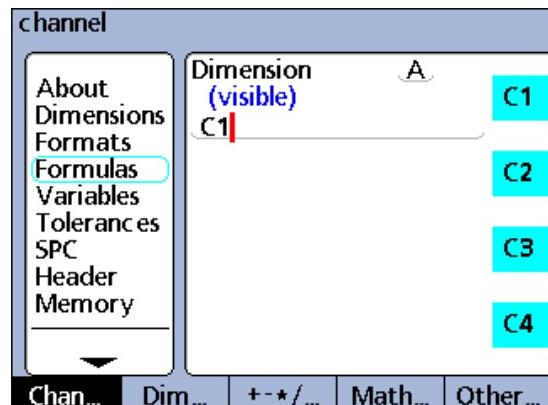
Directly assigned channel function.

Dimension functions

Dimension function values are determined by formulas acting on channel functions, constants or other dimension functions. Dimensions can be visible on the views and stored in the ND 2100G database, or can be hidden and used to perform actions or define custom ND 2100G functions.

Dimension values can be offset using the Preset function. The Preset function is available to operators using the front panel PRESET soft key, and can also be used in formulas.

| Channel References | ▶ | **Dimension Formula** | ▶ | **Preset and Zero Functions** | ▶ | New Dimension Reference |

Channel References ▶

Dimension References ▶ → **Dimension Formula** ▶ → **Preset and Zero Functions** ▶ → **New Dimension Reference**
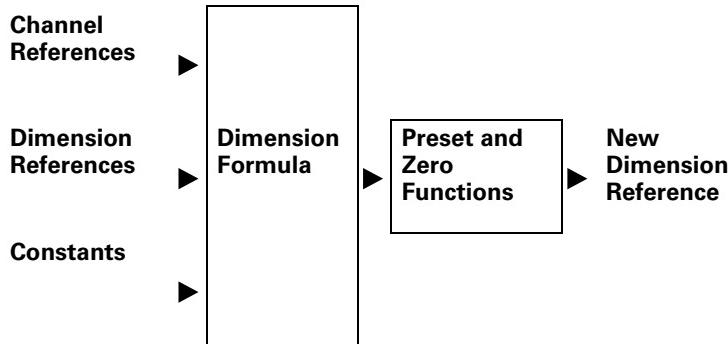
Constants ▶

Channel functions, dimensions and constants are processed before becoming new dimension values that are used in formulas.

Insert dimension functions into formulas to include values of existing dimensions in new dimensions.

To insert a dimension into a formula:

▶ Press the DIM... soft key

▶ Press the dimension key for the dimension you would like to insert

Dimension values can be assigned to other dimensions or used in calculations as shown in this example:

Example 1: Assigned to other dimensions

A=**B**

Example 2: Used in Calculation

A = Len*Wid

Where:

A = Area of a rectangle

Len = Length of a rectangle

Wid = Width of a rectangle
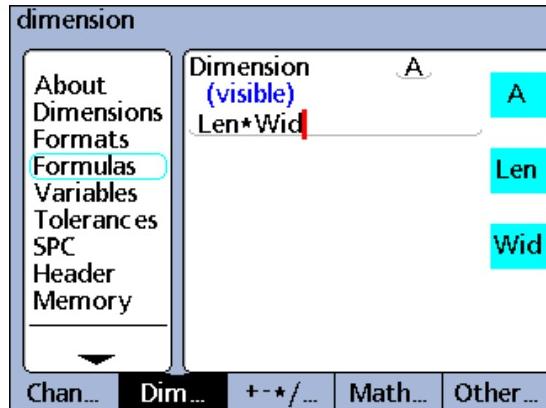
Arithmetic operators

Arithmetic operators are used to add, subtract, multiply and divide. The use of arithmetic operators in ND 2100G formulas is consistent with the use of arithmetic operators generally.

Order of arithmetic evaluation

The order of evaluation of a collection of terms follows generally accepted practice:

Evaluation	Arithmetic
First	Terms in parentheses, innermost first
Second	Exponentiation
Third	Multiplication and division
Fourth	Addition and subtraction

Insert arithmetic operators into formulas as required by the application.

To insert arithmetic operators:

▶ Press the +-*/... soft key
▶ Press the dimension key for the arithmetic operator you would like to insert

Arithmetic operators are combined with constants and variables to define dimensions:

Operator	Example
Addition	A = C1+C2
Subtraction	B = 10-C1
Division	C = C1/1.5
Multiplication	D = 2*Pi*C1

Parentheses

Parentheses are used to group terms within a formula for convenience and to improve readability. Grouped terms enclosed by parentheses are evaluated first and treated as a single term by the formula. Parentheses control the order of evaluation and make complex formulas easier to construct and read.

⚠ Parentheses must be used in opposing pairs. When a formula construction is complete, verify that the number of open parentheses equals the number of closed parentheses. Unmatched parentheses will generate formula error messages.
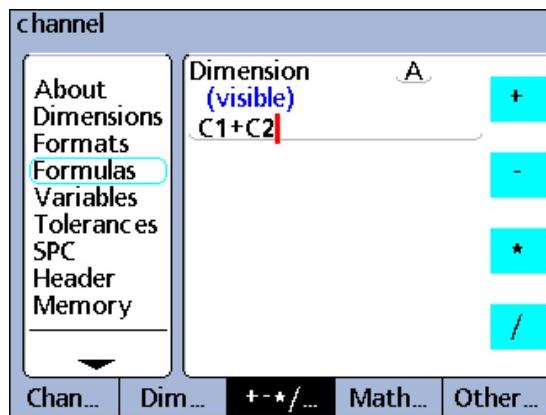
Addition in a formula.

Insert parentheses into formulas as required by the application.

To insert parenthesis:

▶ Press the +-*/... soft key repeatedly until parenthesis ( ) are shown on the right of the screen

▶ Press the open (or close) parenthesis dimension key

Parentheses are combined with arithmetic operators, math functions, constants and variables to define dimensions:

Example:

A = (Pi*(C1exp2))/4

Where:

(C1exp2) is the quantity C1 raised to the second power

(Pi*(C1exp2)) is the entire numerator grouped as a single variable for division.

Units of measure

Dimensions acquire units of measure from channel functions, dimension functions and constants used in their defining formulas. For example, formulas containing numeric channel functions and numeric constants will produce numeric dimensions without units of measure.

⚠️ If combining and mixing units of measure in formulas violates standard math or physics conventions, type or mismatch errors will be generated.

Parentheses in a formula.

Basic math functions

Basic math functions include:

Function	Description
sqrt	Square root
exp	Exponentiation
Trig functions	sin, cos, tan, asin, acos, atan
abs	Absolute value
int	Integer
pi	Constant

Square root functions (sqrt)

The square root function (sqrt) is used to calculate the square root of a term. Square roots can be calculated for any dimensionless single term or collection of terms, or for terms that have square units of measure such as square inches.

To insert the square root function:

▶ Press the MATH... soft key
▶ Press the SQRT dimension key

Square root function syntax

A = **sqrt**(term)

Example:

A = **sqrt**(B)

A = 4 mm when B = 16 mm^2
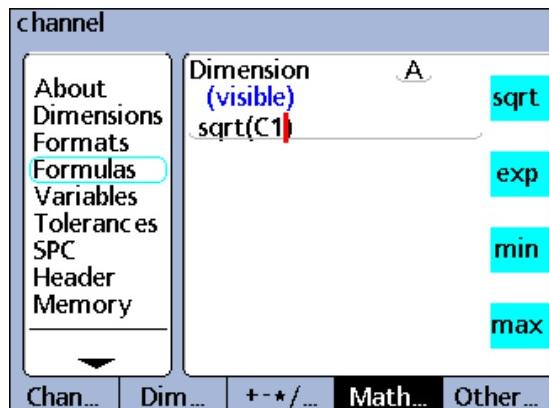
Square root function.

Exponent function (exp)

The exponent function (exp) is used to raise a term or collection of terms to a power. Exponents can be any unitless value or collection of values.

To insert the exponent function:

▶ Press the MATH... soft key
▶ Press the EXP dimension key

Parentheses must be applied where a collection of terms or values is used in an exponent function.

Exponent function syntax

A = Term**exp**value

B = Term**exp**(Collection of values)

Example 1:

A = C1**exp**3

A = 8 mm^3 when C1 = 2 mm

Example 2:

B = C2**exp**(C3+2)

B = 81 mm^4
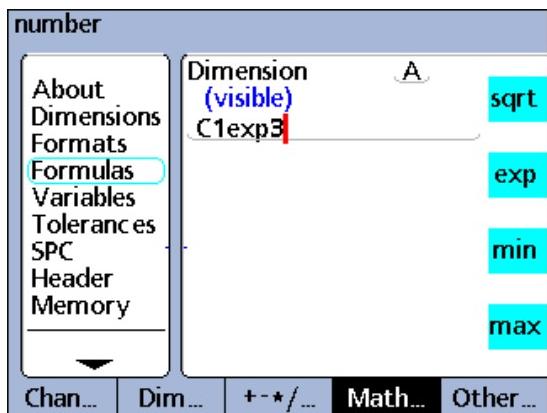
When C3 = 2 and C2 = 3 mm

Exponent function, single value.
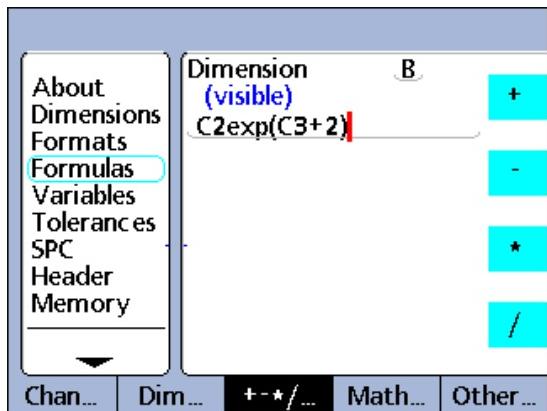
Exponent function, collection of values.

Trig and inverse trig functions (sin through atan)

Trig functions are used to calculate the sine, cosine or tangent of a term. Trig functions can be applied to any angular or numeric term or collection of terms, and will return dimensionless values.

Inverse trig functions are used to calculate the arcsine, arccosine, or arctangent of a term. Inverse trig functions can be applied to any dimensionless term or collection of terms, and will return angular values.

To insert a trig or inverse trig function:

▶ Press the MATH... soft key

▶ Press the dimension key for the trig or inverse trig function you would like to insert

Parentheses for the term are provided. Terms can include channel inputs, dimensions and constants.

Trig function.

Trig function syntax

A = **tan**(term)

Example:

A = **tan**(B)

A = 1 when B = 45 degrees

Inverse Trig function syntax

C = **atan**(term)

Inverse trig function.

Example:

C = **atan**(C1)

C = 45 degrees when C1 = 1
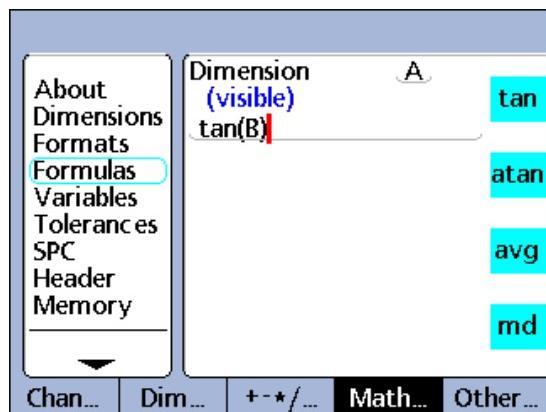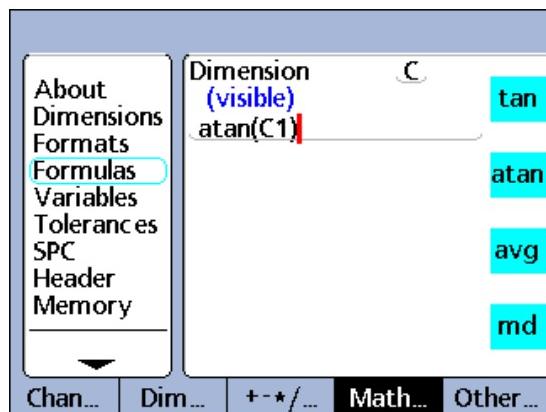
Absolute value (abs) function

The Absolute value function is used to remove the sign from a negative term. Insert the Absolute value function to include the absolute value of a channel input, dimension or collection of terms.

To insert the absolute value function:

▶ Press the MATH... soft key
▶ Press the ABS dimension key

Parentheses for the term are provided.

Absolute value function syntax

A = **abs**(term)

Absolute value function, single value.

Example 1:

A = **abs**(C1)

A = 3 when C1 = -3 or +3

Example 2:

B = **abs**(C2+C3)

B = 17 when C2 = -19 and C3 = +2
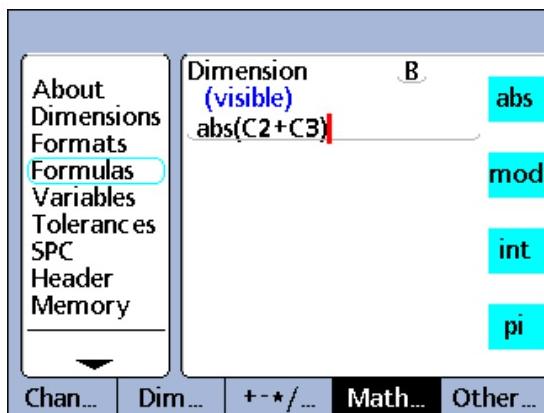
Absolute value function, collection of values.

Integer function (int)

The integer function is used to remove the fractional portion from a term, leaving only the integer portion. The integer function does not round mixed numbers. The fractional portion is removed. The Integer function includes the integer value of a channel input, dimension or collection of terms.

To insert the integer function:

▶ Press the MATH... soft key
▶ Press the INT dimension key

Parentheses for the term are provided.

Integer function syntax

A = **int**(term)

Integer function, single value.

Example 1:

A = **int**(C1)

A = 2.000 mm

when C1 = 2.9732 mm

Example 2:

B = **int**(C2+2.71mm+C3)

B = 6.000 mm

when (C2 = 2.21 mm and C3 = 1.789 mm
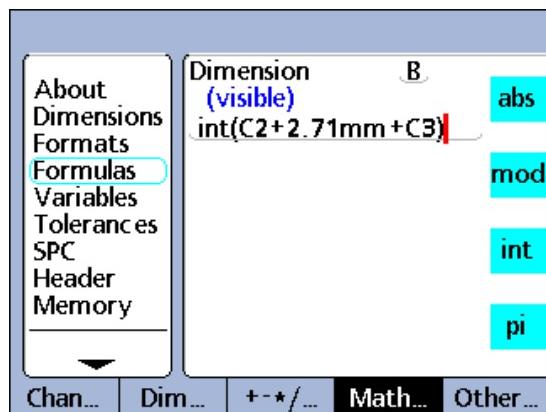
Integer function, collection of values.

Pi and other constants

Constants are numeric values that do not change. The constant pi, or numbers entered from the numeric keypad are examples.

Insert constants into formulas to add, subtract, multiply, divide or raise a value to a power. Numeric constants are also used as arguments in logical, data evaluation and measurement control functions described later in the Advanced Functions portion of this chapter.

To insert a constant:

▶ Press numeric keypad keys to enter numbers. The number will be displayed in a separate Enter Number popup screen.
▶ Press the soft key for the desired unit of measure or the NONE soft key for constants with no units of measure

To insert Pi:

▶ Press the MATH... soft key
▶ Press the PI dimension key

Constant function syntax

A = **2.71**

Pi function syntax

A = (**Pi***(C1exp2))/4

Where:

A = Area in units^2

pi = unitless constant 3.14...

2 = unitless constant used as a power of C1

4 = unitless constant used for division
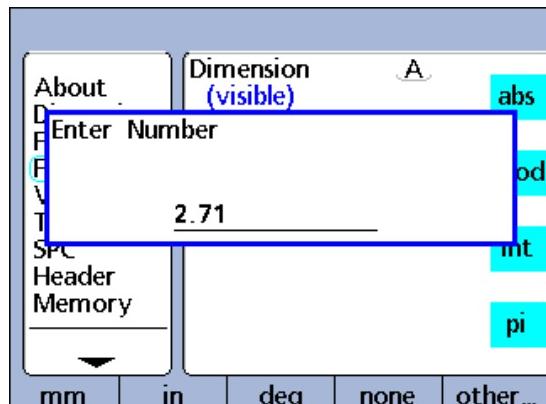
Constant function.
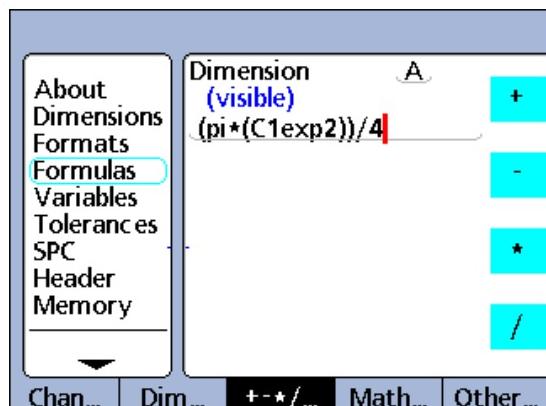
Pi function.

Advanced formula functions

Advanced functions are used in visible and hidden dimension formulas to assign values, perform conditional tests and perform actions.

Example 1:

A = if(C1>1.5mm,dmn(C2),dmn(C3))

The formula assigns a value to visible dimension A that depends on the input value of C1. When C1 is greater than 1.5 mm, the dynamic minimum value of C2 is assigned to A, otherwise, the dynamic minimum value of C3 is assigned.

Example 2:

H1 = if(fail(),Relay(1,1),Relay(1,0))

A hidden dimension is used. Output relay 1 is set to its energized state (closed) when any tolerance test fails, otherwise, the relay is set to its deenergized state (open). Since a hidden dimension is used, no data is recorded in the ND 2100G database.

Advanced formula functions:

+ - * /	Math	Other
,	min	if
;	max	case
>	avg	seq
>= (≥)	md	trip
<	mod	dmn
<= (≰)		dmx
== (=)		davg
!= (≠)		dmd
&& (AND)		fail
||(OR)		xtra
-- (RANGE)		copy
		paste

xtra menu		
Ask	Global	Report
Beep	HwDmn	RsetDyn
ClrAllD	HwDmx	Scan
ClrData	HwLx	Send
ClrTrig	Lookup	SendMsg
DateStr	Loop	SendRec
Din	Master	SetColor
DinBin	MaxIndex	SetTrig
Display	MinIndex	Setup
Dout	OnEvent	Time
DoutBin	PartNo	TimeStr
FnCall	Preset	Var
FnDefine	Recall	Xlatch*
FnParam	Relay	
FnReturn	Remark	

Advanced functions include +-*/, Math and Other menus:

■ Comma: Separate arguments for a single formula

■ Semicolon: Separate formulas for a single dimension

■ Greater than (>): Logical test criterion

■ Greater than or equal to (>=): Logical test criterion

■ Less than (<): Logical test criterion

■ Less than or equal to (<=): Logical test criterion

■ Equal to (==): Logical test criterion

■ Not equal to (!=): Logical test criterion

■ AND (&&): Logical test condition

■ OR (||): Logical test condition

■ RANGE (--): Inclusive range of values between two specified points

■ Minimum value (min): Return the minimum value from a list

■ Maximum value (max): Return the maximum value from a list

■ Modulo (mod): Return the remainder value from a division operation

■ If: Logical true/false test that controls decisions and process flow

■ Case: Logical range test that controls decisions and process flow

■ Sequence (seq): Control process to follow predetermined sequence of steps

■ Trip: Automate process or SPC entry based on channel input or dimension levels

■ Dynamic minimum (dmn): Return the minimum sampled input value

■ Dynamic maximum (dmx): Return the maximum sampled input value

■ Dynamic average (davg): Return the average sampled input value

■ Dynamic median (dmd): Return the median sampled input value

■ Fail: Return logic levels for dimension tolerance pass/fail

■ Xtra: An additional menu of functions is accessed through the Xtra item and discussed later in this chapter

Commas (,)

Most advanced functions require or permit the use of multiple arguments to support function calculations. When multiple arguments are used in a function, the comma is used to separate the arguments. Many advanced functions provide parentheses that include commas. In other cases, parentheses and commas must be added by the user. Insert commas into formulas as required by the function.

To insert a comma:

▶ Press the +-*/... soft key
▶ Press the , dimension key

Comma syntax

A = Function(arg1, arg2, arg3, ...argn)
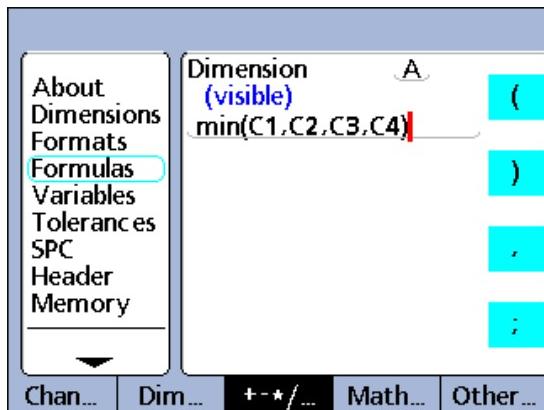
Comma separated arguments.

Example:

A = min(C1,C2,C3,C4)

A = the minimum of channel inputs C1, C2, C3, and C4

Semicolon (;)

The ND 2100G permits the use of multiple formulas on a single dimension formula screen. When multiple formulas are used on a dimension screen, the semicolon is used to separate the formulas. When multiple formulas are included on one dimension screen, the leading formula defines the value of a dimension, while subsequent formulas perform some kind of operation. The dimension value is stored in the ND 2100G database. The actions performed by subsequent formulas can change relay states, set output data, set variables and so on. Insert semicolons into dimension screens between formulas as required.

To insert a semicolon:

▶ Press the +-*/... soft key

▶ Press the ; dimension key

Semicolon syntax

A = Function 1(arg1, arg2, ...argn); Function 2(arg1, arg2, ...argn)
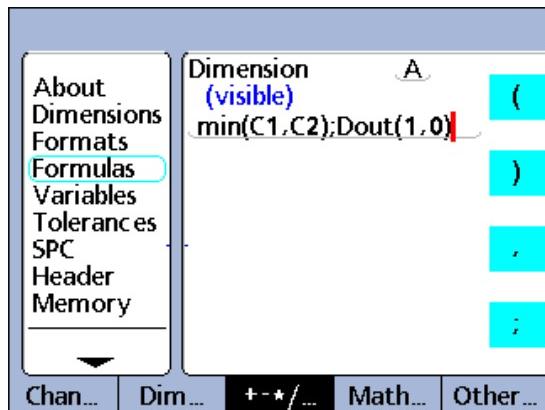
Semicolon separated formulas.

Example:

A = min(C1,C2);Dout(1,0)

A = the minimum of channel inputs C1 and C2

and

Output pin 1 of the primary parallel I/O port will be set to a logic 0

Logical and control

Logical functions assign values to dimensions or perform operations based on true/false and sorting tests of specified terms. True/false tests are performed by the If function. Sorting tests are performed by the Case function. Each test type uses the same set of test criteria and conditions.

The logical test criteria functions are only included in If and Case functions for true/false and sorting tests.

Test criteria include:

1 Greater than (>)

5 > 3 is true   5 > 5 is false   5 > 6 is also false
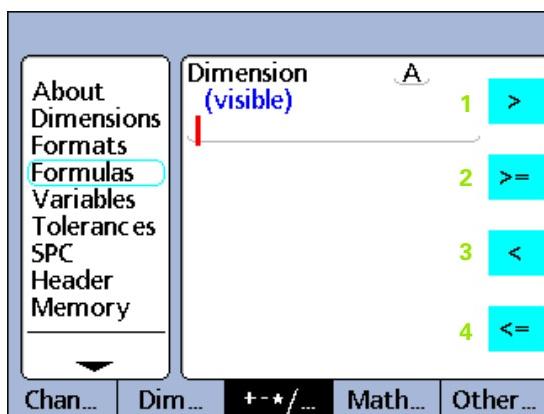
2 Less than (<)

3 < 5 is true   3 < 3 is false   3 < 2 is also false

3 Greater than or equal to (>=)

5 >= 3 is true   3 >= 3 is also true   3 >= 4 is false
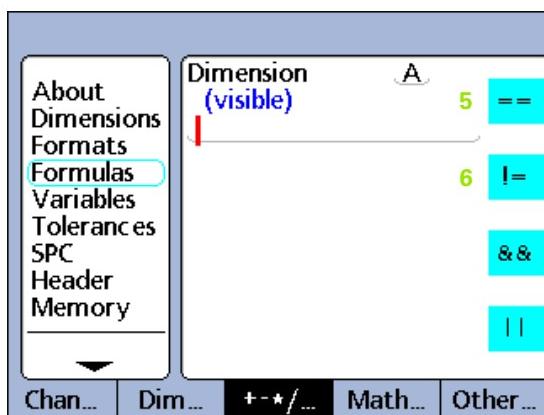
4 Less than or equal to (<=)

3 <= 5 is true   3 <= 3 is also true   3 <= 2 is false

5 Equal to (==)

5 == 5 is true   5 == 4 is false

6 Not equal to (!=)

5 != 4 is true   5 != 5 is false

To insert a test criteria function:

▶ Press the +-*/... soft key
▶ Press the dimension key for the test criteria you would like to insert

Logical test criteria.

The logical test condition functions are only included in If and Case functions for true/false and sorting tests.

Test conditions include:

7 Logical AND (&&)

True only when all values tested fit criterion

Example:

For the condition (C1==2)&&(C2>1)

(C1==2)&&(C2>1) is false	when C1 = 1.9 and C2 = 2.0
(C1==2)&&(C2>1) is false	when C1 = 1.9 and C2 = 2.5
(C1==2)&&(C2>1) is true	when C1 = 2.0 and C2 = 2.0
(C1==2)&&(C2>1) is true	when C1 = 2.0 and C2 = 2.1

8 Logical OR (||)

True when any value tested fits criterion

Example:

For the condition (C1==2)||(C2>1)

(C1==2)||(C2>1) is false	when C1 = 1.9 and C2 = 1.0
(C1==2)||(C2>1) is true	when C1 = 1.9 and C2 = 2.5
(C1==2)||(C2>1) is true	when C1 = 2.0 and C2 = 1.9
(C1==2)||(C2>1) is true	when C1 = 2.0 and C2 = 2.1

9 RANGE (--)

The evaluation of Range depends on the formula that includes it.

Example:

Ranges can be included in the following formula functions:

Din	Dout	MinIndex
RsetDyn	MaxIndex	
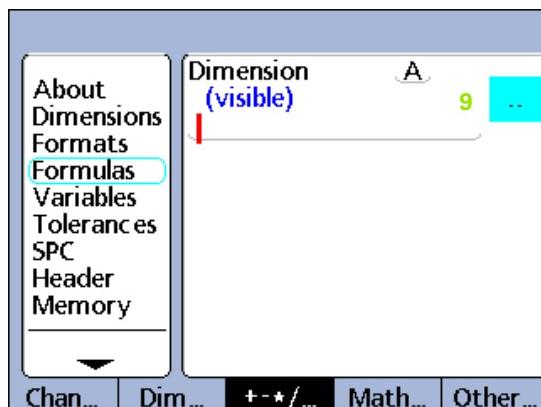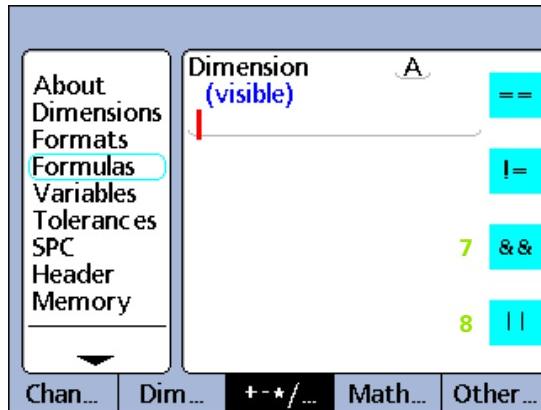
Logical test conditions.

Din

Din ranges can only be specified for the data input pins of the parallel connector.

Din syntax

Din (1--n)
Specifies Din (1) through Din (n).

Example:

If(Din(1--4)>0,SendRec,0)

If any Din in the range Din (1) through Din (4) is greater than zero, send our record, otherwise do nothing.

Dout

Dout ranges can only be specified for the data output pins of the parallel connector.

Dout syntax

Dout (1--n)
Specifies Dout (1) through Dout (n).

Example:

Dout(1--4,1)

Sets all Dout in the Range Dout(1) through Dout(4) to a logic 1.

MinIndex and MaxIndex

The index location of the minimum or maximum value in a range can be specified for channels, dimensions and system dimensions.

MinIndex and MaxIndex syntax

MinIndex(V1--Vn) or **MaxIndex(V1--Vn)**
Specifies the location within the parentheses (index) of the minimum or maximum value.

Example:

A= MaxIndex(C1--C4)

Dimension A is assigned a number 2 when C2 is the maximum value in the range channel 1 through channel 4.

RsetDyn

RsetDyn range can only be specified for dimensions.

RsetDyn syntax

RsetDyn(A--E)
RsetDyn range can be used to dynamically reset a range of dimensions.

Example:

 RsetDyn(A--E)

Performs a reset of all dynamic functions for dimensions in the range dimension A through dimension E.

If function

The If function performs a logical true/false test and assigns a value to a dimension or performs an operation based on the outcome of the test. The logical test uses test criteria and conditions described earlier. Tests can be performed on channels, dimensions, system dimensions, custom ND 2100G functions, parallel port input pins, database contents, time, output relay state and variables.

To insert the If function:

▶ Press the OTHER... soft key

▶ Press the IF dimension key

If function.

If function syntax

A = **if** (Logical test criterion, result when true, result when false)
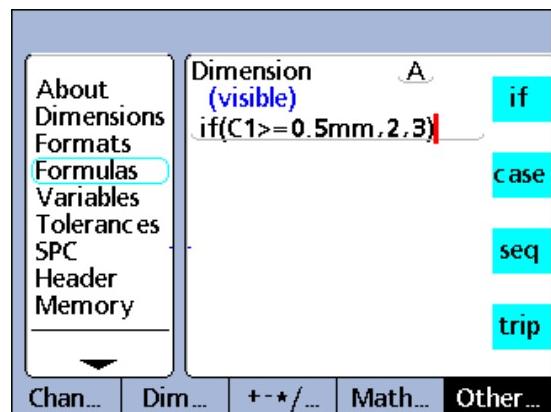
Example 1: A value is assigned to a visible dimension

A = **If**(C1>=0.5mm,2.0,3.0)

A = 2.0 when C1 is greater than or equal to 0.5 mm

A = 3.0 when C1 is less than 0.5 mm

Example 2: An If function is appended to a dimension formula using the semicolon function. This If function performs an operation; it engages or disengages relay contact 1 depending on the value of C4.

A = C4;**If**(C4>=5mm,Relay(1,1),Relay(1,0))

A = C4 and Relay 1 engages when C4 is greater than 5 mm

A = C4 and Relay 1 disengages when C4 is equal to or less than 5 mm

This If function could also be assigned to a hidden dimension:

H1 = **If**(C4>=5mm,Relay(1,1),Relay(1,0))

Suppressing If logical test results

When the If function is used to perform operations, the true or false result can be suppressed by inserting a numeric zero constant in either the true or false result position. In this example, no operation is performed when the logical test result is false.

H1 = If(Fail(),Beep,0)

Case function

The Case function performs logical sorting tests to assign values to dimensions or perform operations based on the test result case, or classification. The logical tests use test criteria and conditions described earlier. Tests can be performed on channels, dimensions, system dimensions, custom ND 2100G functions, parallel port input pins, database contents, time, output relay state and variables.

To insert the Case function:

▶ Press the OTHER... soft key

▶ Press the CASE dimension key

Case function.

Case function syntax
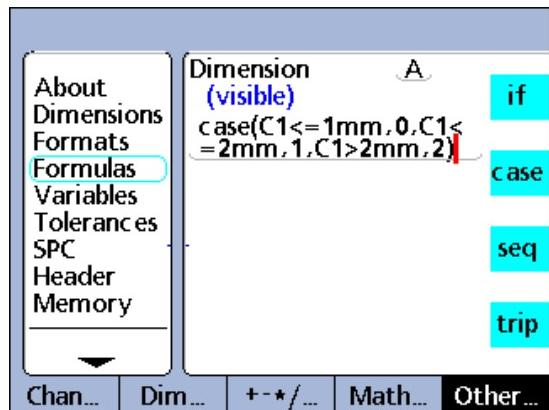
A = **Case**(Test 1, result 1, test 2, result 2, ...test n, result n)

Example 1: A value is assigned to a visible dimension

A = **Case**(C1<=1mm,0,C1<=2mm,1,C1>2mm,2)

A = 0 when C1<=1 mm

A = 1 when C1<=2 mm

A = 2 when C1>2 mm

Example 2: A Case function is appended to a dimension formula using the semicolon function described earlier. This Case function will perform an operation; it sends one of three messages depending on the value of C1.

A = C4;**Case**(C1<=1mm,SendMsg"Case 1",
C1<=2mm,SendMsg"Case 2",C1>2mm,SendMsg"Case 3")

A = C4 and when C1<=1 mm the message "Case 1" is sent to the RS-232 port

A = C4 and when C1<=2 mm the message "Case 2" is sent to the RS-232 port

A = C4 and when C1>2 mm the message "Case 3" is sent to the RS-232 port

This Case function could also be assigned to a hidden dimension:

H1 = **Case**(C1<=1mm,SendMsg"Case 1",C1<=2mm,SendMsg"Case 2",C1>2mm,SendMsg"Case 3")

Suppressing Case sort results

When the Case function is used to perform operations, any sort result can be suppressed by inserting a numeric zero constant in the sort result position. In the example shown below, no operation is performed for the second sort result.

H1 = Case(C1<=1mm,SendMsg"Case 1",C1<=2mm,0 "Case 2",C1>2mm,SendMsg"Case 3")

> Case function tests are performed from left to right and only one result will be generated. This precludes the possibility of more than one result being generated for a single Case function. For example, while a value of 0.75 for C1 in the example above would satisfy the first two tests, only the first test will generate a result.

Incomplete case sets and default cases

Case functions use logical test criteria and conditions to sort a potentially broad set of inputs into a relatively small collection of well-defined output categories. This logical sorting works well unless the inputs include a case that is not defined as an output category.

Each Case function must include a complete set of cases. A Case function with an incomplete case set will not work and will generate an error message.

Example:

A = **Case**(C1<1,0,C1>1,1)

A = 0 when C1<1

A = 1 when C1>1

A is undefined when C1=1

The case C1=1 must be included to provide a complete set of cases.

Default cases provide an output category for any inputs that do not fit into the defined set of cases.

Default Case function syntax

A = **Case**(Test 1, result 1, test 2, result 2, test n, result n...empty test, default result)

All inputs that do not fit into defined case sets produce the default result. Revising the example shown on page 202 to include a default case results in the following:

A = **Case**(C1 < 1,0,C1 > 1,1, ,2)

A = 0 when C1 < 1

A = 1 when C1 > 1

A = 2 when C1 = 1

While it is relatively easy to define complete sets of cases for simple applications, it is good practice to include default cases in all Case function formulas, thereby avoiding the possibility of undefined results.

Minimum (min) and maximum (max) functions

The min or max functions are used to find minimum or maximum values in a specified list. The list of values can include channels, dimensions and database content. The min or max functions can be used to assign values to dimensions, system dimensions, custom ND 2100G functions or specify criteria for a comparison test.

To insert a Min or Max function:

▶ Press the MATH... soft key
▶ Press the MIN or MAX dimension key

Min function syntax

A = **min**(value1, value2, ...value n)
Assigns the minimum list value to A

Example: Multiple terms are grouped by parentheses and treated as a single term.

A =**min**((C1+C2),C3)

A =3 mm when C1 = 1 mm, C2 = 2 mm, and C3 = 4 mm

Max function syntax

A = **max**(value1, value2, ...value n)
Assigns the maximum list value to A

Example:

A =**max**(C1,C2,C3)

A = 6 mm when C1 = 6 mm, C2 = 3 mm and C3 = 2 mm
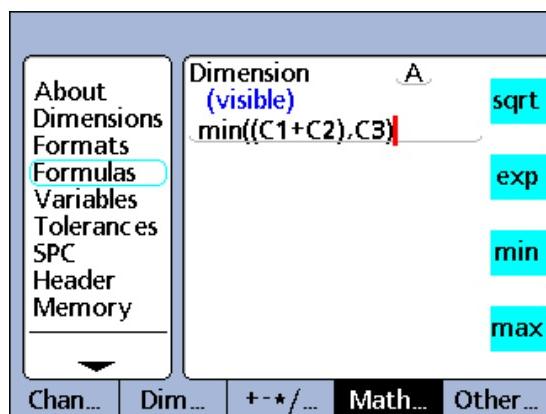
Min function.
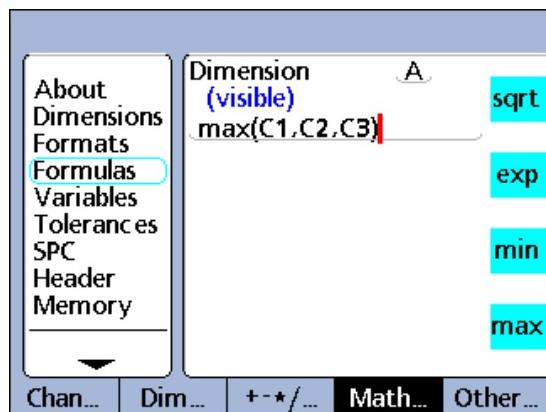
Max function.

Min and max functions can be used to evaluate many inputs simultaneously to produce a single result. The flatness measurement in this example illustrates this (many channels to one dimension) capability. The multiple channel inputs are distributed across a surface, and then flatness is evaluated by simultaneously calculating the difference between the highest and lowest points on the surface.

F = **max**(C1,C2,C3,C4) - **min**(C1,C2,C3,C4)
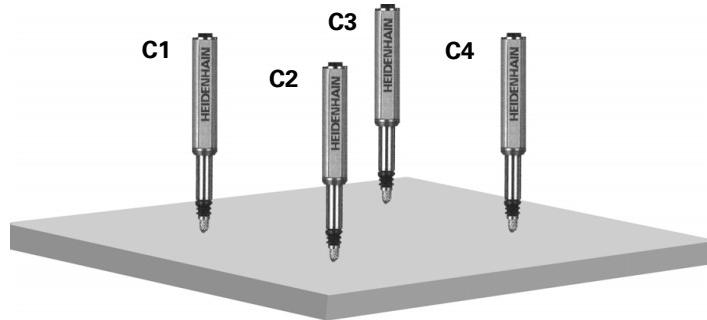
> Min and max functions will not accept mixed units of measure.

Average (avg) and median (md) functions

The avg or md functions are used to find average or median values in a specified list. The list of values can include channels, dimensions and database content. The avg or md functions can be used to assign values to dimensions, system dimensions, custom ND 2100G functions or specify criteria for a comparison test.

To insert a avg or md function:

▶ Press the MATH... soft key

▶ Press the AVG or MD dimension key

Avg function syntax

A = **avg**(value1, value2, ...value n)

Assigns the average list value to A
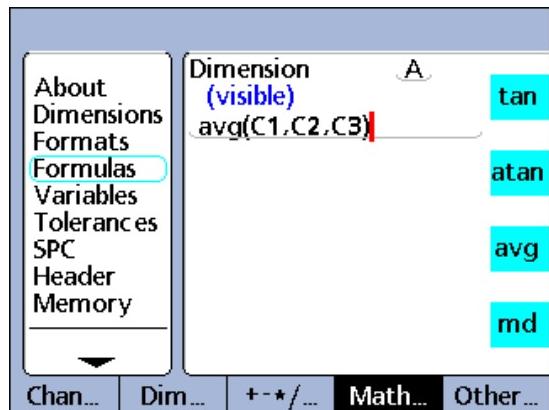
Example:

A =**avg**(C1,C2,C3)

A = 3.67 mm when C1 = 6 mm, C2 = 3 mm and C3 = 2 mm

Md function syntax

A = **md**(value1, value2, ...value n)

Assigns the median list value to A
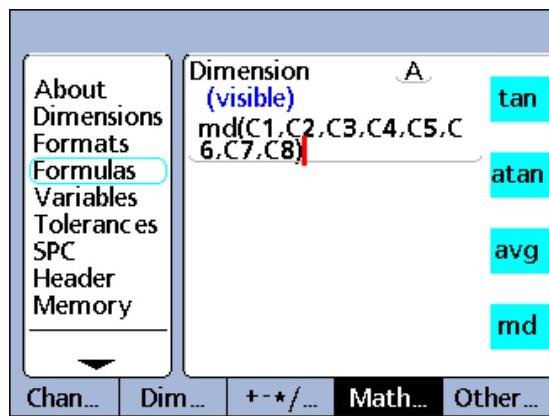
Example:

A = **md**(C1,C2,C3,C4,C5,C6,C7,C8)

A = 3.5 mm when C1 = 2 mm, C2 = 2 mm, C3 = 2 mm, C4 = 3 mm, C5 = 4 mm, C6 = 5 mm, C7 = 6 mm, C8 = 6 mm

> Avg and md functions will not accept mixed units of measure.

Average function.

Median function.

Modulo (mod) function

The Modulo (mod) function is used to return the remainder of a division operation. Modulo values can be calculated for any term or collection of terms. The dividend and divisor are specified by the user as arguments of the mod function. When the division is performed, the remainder is assigned to a dimension.

To insert a mod function:

▶ Press the MATH... soft key
▶ Press the MOD dimension key

Mod function syntax

A = **mod**(Dividend, divisor)

Results of the formula in the example below are shown in the accompanying table for some values of C1 from 0 to 120 in regular increments of 12

Example:

A = **mod**(C1,60)

C1	mod(C1,60)
0	0
12	12
24	24
36	36
48	48
60	0
72	12
84	24
96	36
108	48
120	0
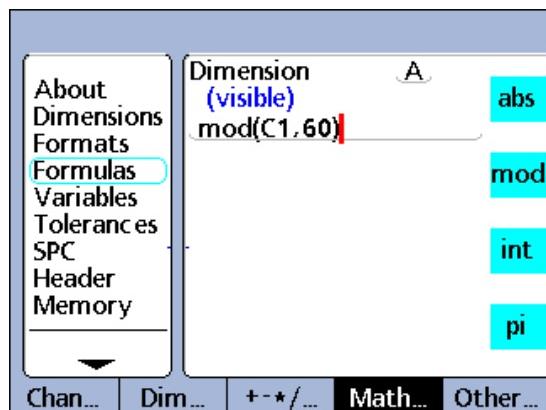
Modulo function.

Sequence (seq) function

The Sequence function (seq) is used to control the order of measurement steps.

Normally, dimension formulas are continuously evaluated and the results entered into the database simultaneously when the ENTER key is pressed or a Trip occurs. However, the sequence function allows database record entries to be made individually in a user-defined sequence. The user defines the sequence by numbering the steps. The steps are then executed one at a time in ascending order each time the ENTER key is pressed or a Trip occurs.

Dimensions calculated from sequence steps are stored in sequence as the ENTER key is pressed. During operation, a blue line appears under the dimension label of the current sequence step. Each time the ENTER key is pressed or a Trip occurs the current step function is stored, and the blue line advances to the next step.

This separation of steps makes it possible to conduct a series of different measurements using the same channel input if desired, and is necessary for the development of applications requiring sequential logic.

To insert the seq function:

▶ Press the OTHER... soft key
▶ Press the SEQ dimension key

Seq function syntax

A = **seq**(Step number, function)

Example: The volume of a rectangular solid calculated from a sequence of 3 measurements using a single channel based on the equation:

Volume = Height * Width * Length

Where:	**Dimension formulas:**
H = height	H = seq(1,C1)
W = width	W = seq(2,C1)
L = length	L = seq(3,C1)
Vol = volume	Vol = H*W*L

To accomplish this sequence of measurements using only one channel, the operator performs the following steps from the beginning of the sequence:

▶ Position the block and channel input to measure height (H)

▶ Press the ENTER key to store the channel value. The ND 2100G advances to the next step in the sequence.

H = seq(1,C1)
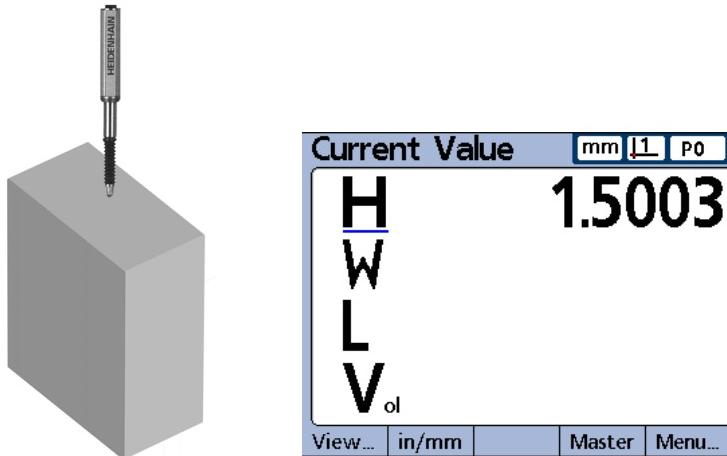
▶ Position the block and channel input to measure width (W)

▶ Press the ENTER key to store the new channel value. The ND 2100G advances to the next step in the sequence.

W = seq(2,C1)
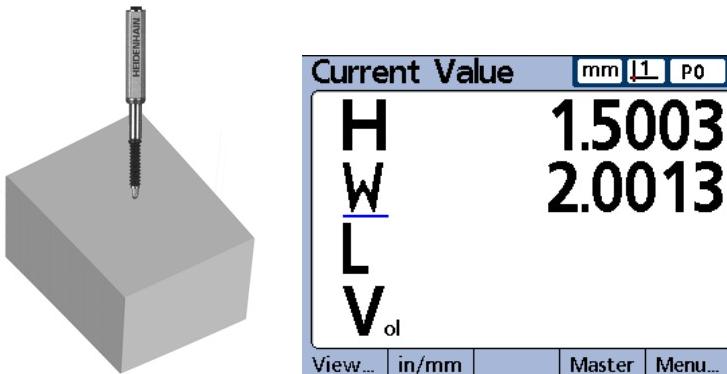
▶ Position the block and channel input to measure length (L)

▶ Press the ENTER key to store the final channel value

L = seq(3,C1)
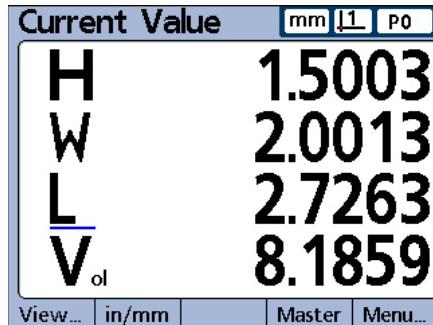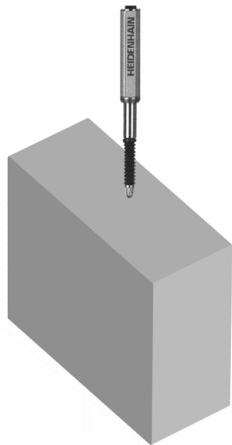
This last step in the sequence also stores the calculation of volume based on the values of H, W and L.

Vol = H*W*L

Upon completion of the last step, the ND 2100G returns to the first step in the sequence to begin a new series of measurements.

This example of volume measurement illustrates that many dimensions can be calculated from a single channel input.

Performing operations within a sequence

Operations such as sending data and engaging relay contacts can be performed within a sequence by appending the operation using a semicolon.

Operations within a sequence syntax

A = **seq**(Step number,function);seq(Step number, operation)

Example:

A = **seq**(3,C1);(3,ClrTrig4)

Clears event trigger 4 when step 3 of the sequence is executed

Reinitiating a sequence

Sequences can be ended prior to their completion and a new sequence initiated.

Reinitiate a sequence syntax

seq(reinitialization step number)

Reinitiate a sequence syntax

Example: Hidden dimension 1 is used to continually evaluate C2, and the sequence is reinitiated at step 1 if the value of C2 exceeds 1.

A= **seq**(1,C1)

B = **seq**(2,C2)

C = **seq**(3,C1+C2)

H1 = if(C2>1mm,**seq**(2),0)

The reinitializing step cannot be embedded in another sequence step.

Trip function and measurement automation

The Trip function automates the data entry (storage) process. Normally, dimension formula calculations are stored in the database only when the ENTER key is pressed. The trip function duplicates pressing the ENTER key by automatically storing formula calculations when a changing value passes through user-defined thresholds.

By automatically storing formula calculations, the trip function allows the operator to conduct a series of identical measurements by loading and unloading parts into and out of a gage.

➡ Measurement automation (the Trip function) can be toggled on and off from the front panel using the hot key Auto function. Refer to the Hot Keys section of Chapter 3: Setup for details regarding hot keys.

The trip function is set and triggered by a value passing through predefined threshold levels. A delay can be included in the trip function to eliminate the effects of hardware noise and settling times.

The trip function thresholds and delay are diagrammed here for a positive-going value. Trip functions can accommodate positive-going and negative-going values. Positive-going and negative-going values are conceptually identical except for direction and polarity of the input.

Once the Trip function has entered a value, it must be reset before it can be used again. The trip function is reset when the monitored value reverses direction and passes back through the set threshold as shown below.
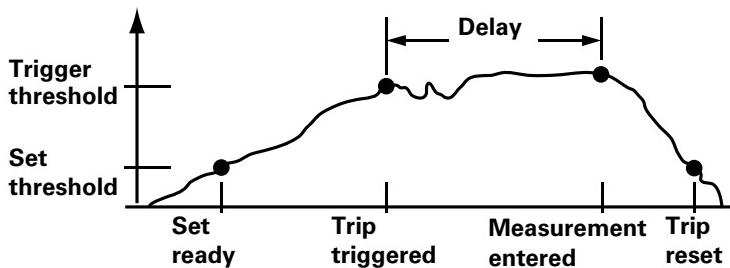
➡ The trip function delay can be set to 0 if hardware settling is not a problem.

The trip function can be used by itself, included in If statements or Case statements as the logical result of either passing or failing a conditional test, or included in a sequence function step.

To insert a Trip function:

▶ Press the OTHER... soft key
▶ Press the TRIP dimension key

Trip function syntax

A = **trip**(Value, set, trigger, delay)

Value can be a term or collection of terms.

Example:

A = **trip**(C1,0.1mm,0.5mm,1.0sec)

A = C1 will be stored in the database after the value of C1 has passed through 0.1 mm, then 0.5 mm and then 1 second has passed.

➡ The examples shown for the Trip function used channel functions. However, any term or collection of terms that have numeric value could as easily have been used.

Continuous sampling using the trip function

Typical applications using the Trip function include the use of set and trigger thresholds as discussed. However, some applications are configured with the input channel devices in constant contact with the surface(s) to be measured, and require continuous input sampling.

Continuous input sampling can be achieved by omitting the set and trigger thresholds from the standard Trip function syntax.

Continuous sampling Trip function syntax

A = **trip**(Value, , , Delay)

The rate of continuous sampling is determined by the Delay parameter and the system refresh time. System refresh time typically varies between 0.03 and 0.10 seconds depending on the number and type of channels used and the complexity of formulas.

The resulting sample rate becomes:

Sample rate = 1/(Total trip function time)
    ~ 1/(System refresh time + Delay time)

Assuming the maximum system refresh time, and no sample Delay, the maximum sample rate is approximately:

Max sample rate = 1/(0.10 + 0)
    = 10 samples/second

Generally applications that require continuous sampling employ slower rates, with seconds, minutes or even more time between samples. For these applications the sample rate can be expressed as the inverse of the user specified delay as shown below.

Sample rate ~ 1/Delay

Application developers generally know the sample rate requirement and need to find the delay parameter to enter into the Trip function. Since sample rate and delay are inversely related, for sample rates less than 10 per second, delay can be expressed as:

Delay ~ 1/sample rate

For example, a sample rate of 1 sample per minute requires a delay of 60 seconds, resulting in the formula parameters shown below.

A = **trip**(C1, , , 60sec)

Continuous samples can be accumulated in the ND 2100G database, transmitted over the RS-232 port or sent to a USB drive.

A = **trip**(C1, , , 60sec);Send

> The Auto hot key function toggles the Trip function on and off. Assign the Auto function to the desired front panel key prior to configuring the Trip function for continuous sampling. Refer to "Hot Keys setup screen" on page 141.

Dynamic minimum (Dmn) and dynamic maximum (Dmx) functions

The dynamic minimum (dmn) and dynamic maximum (dmx) functions assign values to dimensions based on the minimum or maximum values of dynamically sampled channels or dimensions. The sampled values can be assigned directly, or can be used as triggers to assign a value from a second source.

ND 2100G channel inputs are sampled many times per second and the system updates and retains the minimum and maximum values encountered in the sampling process. Minimum and maximum values are evaluated simultaneously during sampling. Dynamic minimum and maximum values can be calculated for any term or collection of terms. Pressing the ENTER button or the Trip function stores the minimum and maximum values.

To insert a dmn or dmx function:

▶ Press the OTHER... soft key
▶ Press the DMN or DMX soft key

Assigning a sampled value.
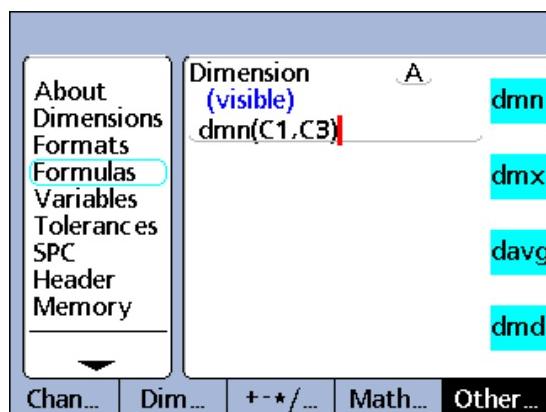
Assigning a second value.

Dmn function syntax

A = **dmn**(Sampled value)
Assigns the sampled minimum value.

A = **dmn**(Sampled value, second source)
Assigns the second source value when the sampled value is at the minimum.

Dmx function syntax

A = **dmx**(Sampled value)
Assigns the sampled maximum value.

A = **dmx**(Sampled value, second source)
Assigns the second source value when the sampled value is at the maximum.

⚠ Due to the relatively low sample rates of the dmn and dmx functions, surfaces must be moved slowly during the sampling process to insure that all points are evaluated. Applications that require faster sample rates and have appropriate input devices should use the HwDmn or HwDmx function described Refer to "HwDmn and HwDmx functions" on page 245.

In this example, the runout of a shaft is determined by spinning the shaft, dynamically measuring the shaft's minimum and maximum diameters and then subtracting the minimum diameter from the maximum diameter.

R = **dmx**(C1)-**dmn**(C1)

➡️ The RsetDyn function discussed on page 245 must be used to clear existing samples before using the dmn and dmx functions.

In another example, the angle between high points of two cams is determined by spinning the cam shaft, dynamically measuring the rotational angle at each cam minimum, and subtracting the smaller angle from the larger angle.

Encoder C1 measures cam 1, encoder C2 measures cam 2, and the rotary encoder C3 measures the rotational angle of the cam shaft as it spins.

A = **dmx**(C2,C3)-**dmx**(C1,C3)

➡️ The RsetDyn function discussed on page 245 must be used to clear existing samples before using the dmn and dmx functions.
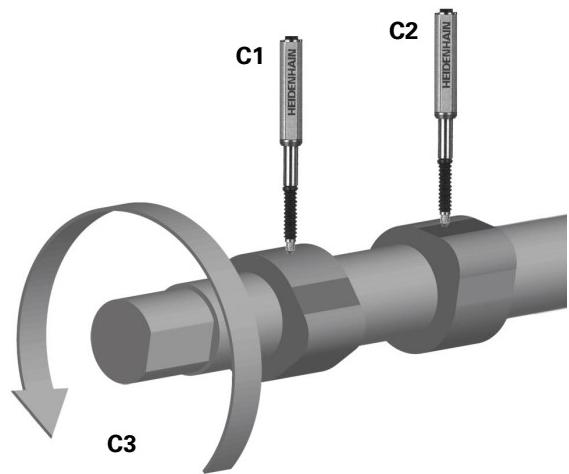
Dynamic average (Davg) and dynamic median (Dmd) functions

The dynamic average (davg) and dynamic median (dmd) functions assign values to dimensions based on the average or median values of dynamically sampled channels or dimensions. The sampled values are assigned directly. Dynamic averages are useful when measuring rough surfaces. Dynamic medians are useful when measuring in the presence of noise.

ND 2100G channel inputs are sampled many times per second and the system updates and retains the average and median values encountered in the sampling process. Average and median values are evaluated simultaneously during sampling. The number of samples used to calculate the average or median is specified as an argument by the user. Smaller numbers of samples have little impact on system performance but result in rapidly changing averages and medians. Larger numbers of samples result in more stable averages and medians but slow system performance.

Dynamic average and median values can be calculated for any term or collection of terms. Pressing the ENTER button stores the average and median values.

To insert a davg or dmd function:

▶ Press the OTHER... soft key
▶ Press the DAVG or DMD dimension key

Davg function syntax

A = **davg**(Sampled value, sample size)
Assigns the average value of the samples. The minimum sample size for averages is 2.

Dmd function syntax

A = **dmd**(Sampled value, sample size)
Assigns the median value of the samples. The minimum sample size for medians is 3.

➡ The sample size must be specified using a dimensionless constant.

The RsetDyn function discussed on page 245 must be used to clear existing samples before using the dmn and dmx functions.

⚠ Due to the relatively low sample rates of the davg and dmd functions, surfaces must be moved slowly during the sampling process to insure that all points are evaluated.
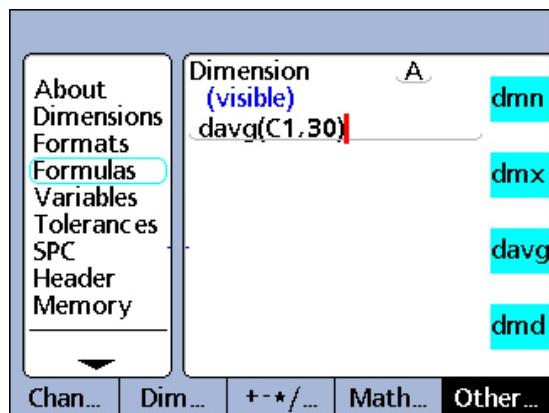
Dynamic average function.
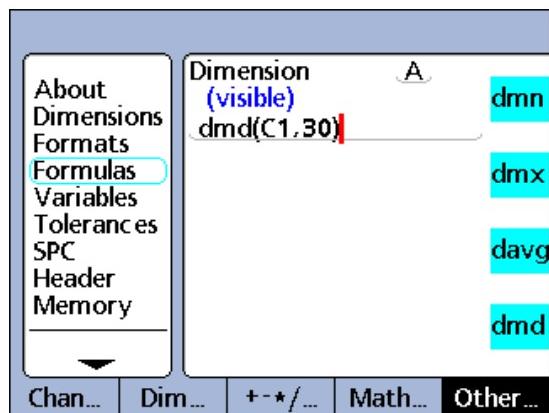
Dynamic median function.

Fail function

The fail function tests the current pass/fail tolerance status of any dimension, list of dimensions provided as the fail argument or of all dimensions. The fail function returns a logic level 0 or 1, indicating the pass or fail status of specified dimensions. The value of 0 or 1 can be assigned to a dimension or can be included in a dimension formula as a logic or dimensionless variable.

To insert a fail function:

▶ Press the OTHER... soft key
▶ Press the FAIL dimension key

Fail function syntax

A = **Fail**()
Assigns a logic 1 to A if any dimension fails a tolerance test.
Assigns a logic 0 to A if all dimensions pass a tolerance test.

A = **Fail**(DimX)
Assigns a logic 1 to A if the specified dimension (X) fails a tolerance test.
Assigns a logic 0 to A if the specified dimension (X) passes a tolerance test.

A = **Fail**(Dim1, Dim2,...DimN)
Assigns a logic 1 to A if any of the specified dimensions fail a tolerance test.
Assigns a logic 0 to A if all of the specified dimensions pass a tolerance test.
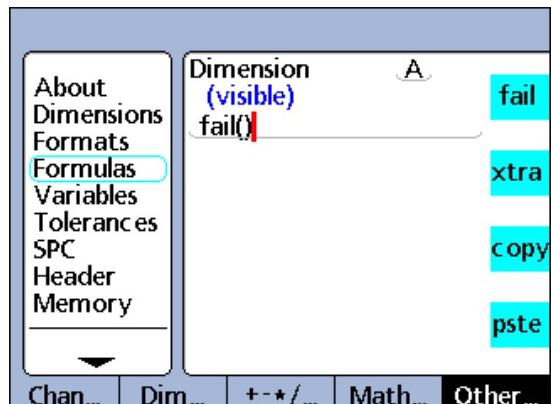
Fail function.

Xtra menu functions

Xtra menu functions are accessed by pressing the OTHER... soft key and then pressing the XTRA dimension key.

Xtra menu functions:

xtra menu		
Ask	Global	Report
Beep	HwDmn	RsetDyn
ClrAllD	HwDmx	Scan
ClrData	HwLx	Send
ClrTrig	Lookup	SendMsg
DateStr	Loop	SendRec
Din	Master	SetColor
DinBin	MaxIndex	SetTrig
Display	MinIndex	Setup
Dout	OnEvent	Time
DoutBin	PartNo	TimeStr
FnCall	Preset	Var
FnDefine	Recall	Xlatch*
FnParam	Relay	
FnReturn	Remark	

Xtra menu functions include:

- Ask: Display a message or prompt the user for keyboard entry, then return the entered value

- Beep: Makes a beep sound

- ClrAllD (Clear all data): Clears data across all parts

- ClrData (Clear data): Clears data for this part

- ClrTrig (Clear trigger): Part of the OnEvent function. Clears the specified event trigger

■ DateStr (Date string): Returns the current system date

■ Din (Data in): Returns logic levels from the primary parallel port input pins

■ DinBin (Data in binary): Returns a base 10 number equivalent to the logic levels from the primary parallel port input pins

■ Display: Sets the current graph display starting at a dimension, with a number a axes

■ Dout (Data out): Applies individually defined logic levels to the primary parallel port output pins

■ DoutBin (Data out binary): Applies binary logic levels to the primary parallel port output pins equivalent to a base 10 number

■ FnCall (Function call): Calls a user defined custom ND 2100G function which returns a value based on arguments passed in the calling statement

■ FnDefine (Function define): Defines a function and includes parameter placeholders for arguments

■ FnParam (Function parameters): Defines up to 12 parameters to be passed to a custom ND 2100G function

■ FnReturn (Function return): Returns immediately from a custom ND 2100G function without returning a value

■ Global: Returns the value of a global variable that is available across all parts

■ HwDmn (Hardware dynamic minimum): Returns the minimum channel input value sampled at high speed by dedicated hardware

■ HwDmx (Hardware dynamic maximum): Returns the maximum channel input value sampled at high speed by dedicated hardware

■ HwLx (Hardware latch): Returns the value of one channel based on the incremental values of another channel

■ Lookup: Returns one of a selection of several dimensions, part values or database values

■ Loop: Loop control used to repeat a series of steps or functions

■ Master: Presets channels to a numeric values contained in the Master screen

■ OnEvent: Evaluate a formula term and return the value or perform a task when a specified event occurs

■ Part number (PartNo): Changes the part number, usually in conjunction with an OnEvent function

■ Preset: Presets a dimension to a numeric value

■ Recall: Recalls dimension values that were specified the last time the Preset function was used

■ Relay: Operate dry-contact relay outputs

■ Remark: Adds a comment to a formula, but has no effect on values or operation

■ Report: Print report on the parallel or serial port

■ Reset dynamic (RsetDyn): Clear dmn, dmx, HwDmn and HwDmx sampled channel input values in preparation for new samples

■ Scan: Collects all channel data at the maximum rate

■ Send: Transmit specified dimension(s) to an output port

■ Send message (SendMsg): Transmit text or ASCII codes to the RS-232 port

■ Send record (SendRec): Transmit a specified dimension record(s) to an output port

■ SetColor: Sets the color of a specified dimension displayed on the DRO

■ Set trigger (SetTrig): Part of the OnEvent function. Sets a user defined event trigger.

■ Setup: Performs a variety of setup functions for the specified dimension

■ Time: Return elapsed time since startup or the amount a formula term has changed over an elapsed time

■ TimeString (TimeStr): Returns the current system time

■ Variable (Var): Returns or initializes the value of a local variable available for individual parts

■ XLatch (Optional): Return a channel input value when an external edge is detected

Ask function

The ask function displays messages that prompt the user for data or display instructions on the LCD. Messages can contain a mixture of up to 80 upper or lower case alphanumeric characters, and can be displayed ONCE when the part is loaded, ALWAYS when a data record is entered, immediately (NOW) upon formula execution or for a TIMED interval specified by the user. The NOW selection should only be used as the result of a OnEvent function to prevent continuous prompting. Numeric data entered by the user in response to a prompt can be interpreted as linear (LIN), angular (ANG), dimensionless (NONE) or a yes or no answer (NO/YES).

The prompt message is displayed to the user in a pop-up box that provides a space for entering the requested data. Data is entered into the pop-up box from the numeric keypad, and stored by the system when the ENTER key is pressed.

To insert the Ask function:

▶ Press the OTHER... soft key
▶ Press the XTRA dimension key
▶ Use the arrow cursor keys to highlight Ask
▶ Press the ENTER key
▶ Press the ONCE, ALWAYS, NOW or TIMED soft key to specify how often the user is prompted
▶ Press the LIN, ANG, NONE or NO/YES soft key to specify the units the response will be in
▶ Use the Alpha Entry screen to create the prompt message
▶ Press the FINISH key

Ask function.

Ask function syntax

A = **ask**When(user prompt)
Using the Ask function to get data.

A = Formula;**ask**DisplayTime(user prompt)
Using the ask function to display a message without user data-entry.
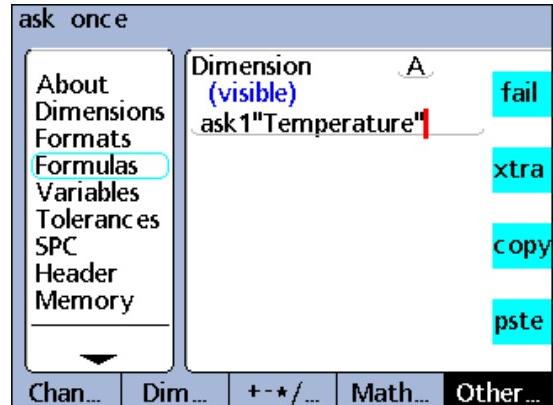
Example 1:

A = **ask1**"Temperature"

Example 2:

A = C3;**askT5**"Part 11"

Beep function

The Beep function generates a beep sound. The volume of beep is determined by the Volume parameter specified in the Misc setup screen, described earlier in this chapter.

To insert the Beep function:

▶ Press the OTHER... soft key
▶ Press the XTRA dimension key
▶ Use the arrow cursor keys to highlight Beep
▶ Press the ENTER key

Beep function syntax

Hn = function (**beep**)

Beep function

Example:

E = if(Fail(),**Beep**,0)

A beep sound is generated if any measurement fails or tolerance test.
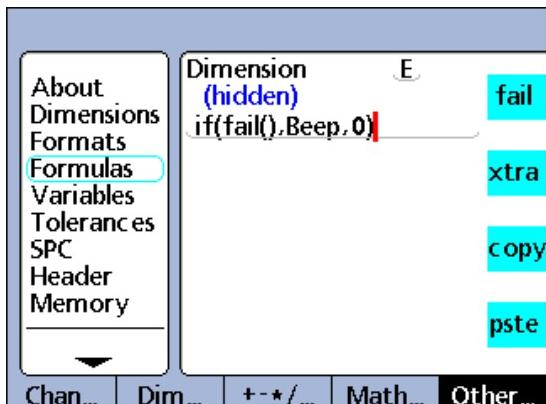
Clear all data function

The Clear All Data (ClrAllD) function clears all data stored in the ND 2100G database for all parts.

To insert the ClrAllD function:

▶ Press the OTHER... soft key
▶ Press the XTRA dimension key
▶ Use the arrow cursor keys to highlight ClrAllD
▶ Press the ENTER key

Clear all data (ClrAllD) function syntax

Hn = **ClrAllD**
Hidden dimension shown.

Example:

H1 = OnEvent9(**ClrAllD**)

All database data is cleared when no numeric data is required and the 9 number key is pressed.

ClrAllD function.

Clear data function

The Clear Data (ClrData) function clears all data stored in the ND 2100G database for the current part.

To insert the ClrData function:

▶ Press the OTHER... soft key
▶ Press the XTRA dimension key
▶ Use the arrow cursor keys to highlight ClrData
▶ Press the ENTER key

Clear data (ClrData) function syntax

Hn = **ClrData**
Hidden dimension shown.

Example:

H1 = OnEvent9(**ClrData**)

All data for the current part is cleared when no numeric data is required and the 9 number key is pressed.

ClrData function.

ClrTrig, SetTrig and user defined events

User defined trigger events cause OnEvent functions to execute once each time a trigger event happens. The trigger event must be set using the SetTrig function before it can cause an event to execute, and then must be cleared using the ClrTrig function before it can be used again.

To insert the Clrtrig or SetTrig function:

▶ Press the OTHER... soft key

▶ Press the XTRA dimension key

▶ Use the arrow cursor keys to highlight Clrtrig or SetTrig

▶ Press the ENTER key

Example:

The value of channel input C1 is assigned to visible dimension A once when the value of C3 exceeds 3 mm.

A = OnEventTrig1(C1)   Defines the trigger event Trig1

An If function is used to set and clear the trigger event using the SetTrig and ClrTrig functions.

H2 = If(C3>3mm,SetTrig1,ClrTrig1)

When C3 > 3 mm, Trig1 is set and causes the OnEvent function shown above to execute once. When C3 <= 3 mm, Trig1 is cleared so that the next time C3 > 3 mm, the OnEvent function can execute again.
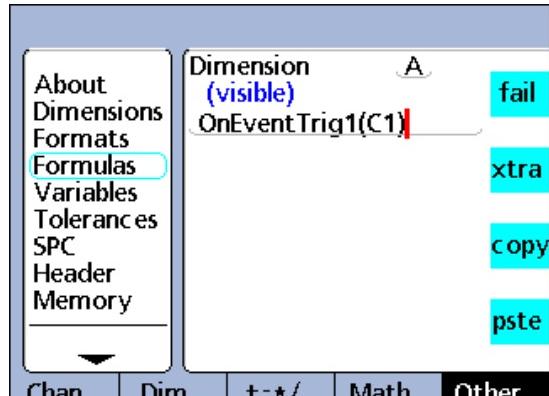
Trigger event 1 defined.
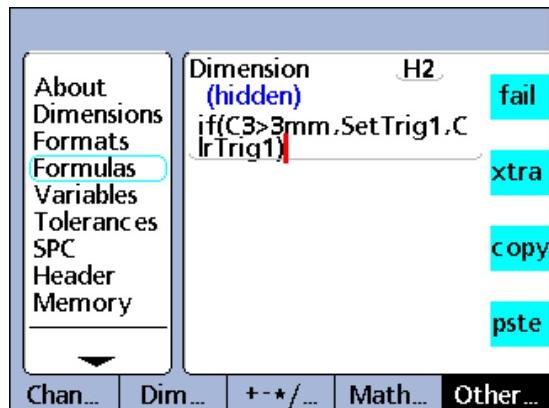
If function sets and clears trigger.

OnEvent function

The OnEvent function is used to assign values to dimensions or to perform operations when triggered by a specified event. When the triggering event occurs, the value is assigned to the dimension and latched, or the specified operation is performed.

When the OnEvent function is inserted, a menu of triggering events is displayed. Triggering events include a collection of system triggering events provided by the menu, and one triggering event that is user-defined. System triggering events cause OnEvent functions to execute each and every time predetermined system events happen. The user defined triggering event causes OnEvent functions to execute each time a user defined event happens.

Triggering events:

|	
DataEntr	Occurs after a data record is entered into the database.
DispOff	Occurs after the display is turned off using the red LCD ON/OFF button.
DispOn	Occurs after the display is turned on using the red LCD ON/OFF button.
Edge1	Occurs after an (Optional) external edge event has happened on external edge line 1.
Edge2	Occurs after an (Optional) external edge event has happened on external edge line 2.
Edge3	Occurs after an (Optional) external edge event has happened on external edge line 3.
HxLx	Occurs after the HwLx function has latched a new value.
Key	Occurs after the specified front panel key has been pressed.
PartClr	Occurs after the part database has been cleared.
PartLoad	Occurs after a new part has been loaded.
PartUnld	Occurs when a part is unloaded.
Playback	Occurs after execution of the scan function, when scanned results are played back.
PowerOn	Occurs at startup.
Trig	User defined triggering event.
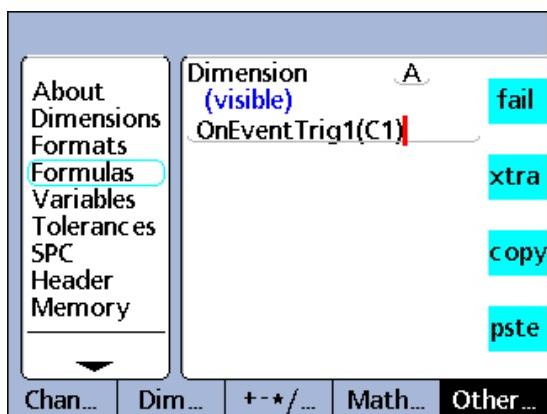
OnEvent function.

To insert a OnEvent function:

▶ Press the OTHER... soft key
▶ Press the XTRA dimension key
▶ Use the arrow cursor keys to highlight OnEvent
▶ Press the ENTER key
▶ Use the arrow cursor keys to highlight a triggering event
▶ Press the ENTER key
▶ Follow screen prompts if any additional steps are required by the triggering event

OnEvent function syntax

A = **OnEvent**Event(Value or operation)

Event equals the triggering event.

Example:

A = **OnEvent**DataEntr(C1)

The value of channel input C1 is assigned to dimension A each time a record is entered into the database.

DateStr function

The DateStr function displays the current system date on the LCD screen in the formats specified in the Clock setup screen. Since the current date value will typically exceed tolerance limits, it is often displayed in the color specified for tolerance failures. The date value is updated during each formula evaluation cycle.

To insert the function:

▶ Press the OTHER... soft key

▶ Press the XTRA dimension key

▶ Use the arrow cursor keys to highlight DateStr

▶ Press the ENTER key

DateStr function syntax

A = **DateStr**

TimeStr function

The TimeStr functions display the current system time on the LCD screen in the formats specified in the Clock setup screen. Since the current time value will typically exceed tolerance limits, it is often displayed in the color specified for tolerance failures. The time value is updated during each formula evaluation cycle.

To insert the TimeStr function:

▶ Press the OTHER... soft key

▶ Press the XTRA dimension key

▶ Use the arrow cursor keys to highlight TimeStr

▶ Press the ENTER key

TimeStr function syntax

B = **TimeStr**
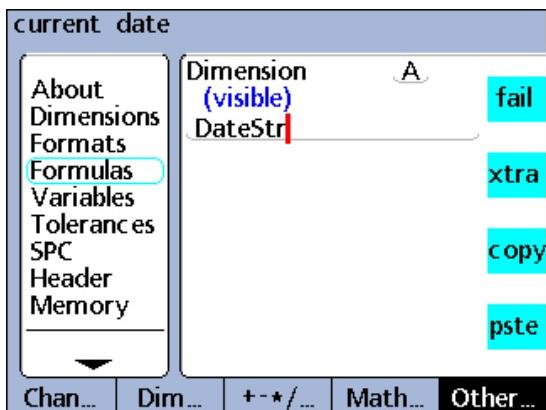
DateStr function.
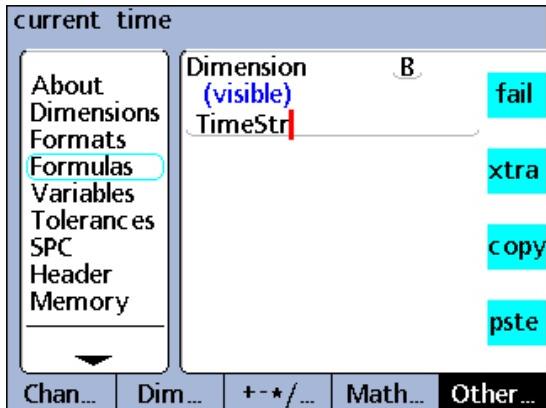
TimeStr function.
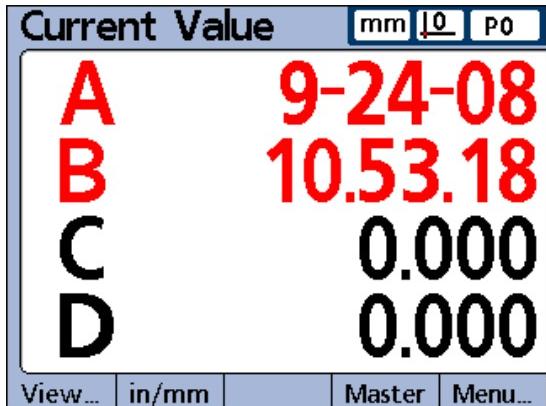
Date and time displayed in DRO screen.

Time function

The Time function is used to assign the elapsed time in seconds since system startup or assign the elapsed time in seconds equal to, or closest to (but exceeding) a specified interval.

To insert the Time function:

▶ Press the OTHER... soft key
▶ Press the XTRA dimension key
▶ Use the arrow cursor keys to highlight Time
▶ Press the ENTER key

Time function syntax

A = **Time**()
Assigns the elapsed time in seconds since system startup.

A = **Time**(Interval)
Assigns the elapsed time closest to a specified interval.

A = **Time**(Interval,value)
Assigns value changes over a specified time interval.
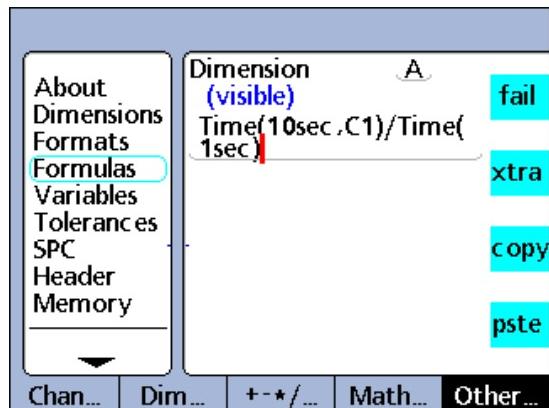
Example:

V = Time(10sec,C1)/Time(1sec)

Uses an elapsed time interval and a value change captured at channel input C1 over the same interval to calculate the exact velocity of the motion of C1.

> The approximation of specific time Intervals is necessary for the exact calculation of velocity and other time related quantities because the system clock is not a precise timekeeping device. By returning a time interval that is known precisely, exact calculations of time related quantities are possible.

Time function.

Din and DinBin function

The primary parallel port is configured as a general-purpose data Input/Output (I/O) port, and does not support parallel printers.

The ND 2100G uses 5 pins of the parallel port connector as the inputs shown below. Inputs support 5 volt TTL logic levels only.

> Electrical characteristics of the parallel port are described under Specifications in this chapter.

Din

Insert the Din function to read the logic level of a single parallel port input pin or range of parallel port pins. The logic level from a single pin can be used in a dimension formula, or the decimal equivalent of the binary values from a range of pins can be used.

To insert the Din function:

▶ Press the OTHER... soft key
▶ Press the XTRA dimension key
▶ Use the arrow cursor keys to highlight Din
▶ Press the ENTER key

The Din pins of the parallel port connector are numbered 1 through 5. Logic levels are referred to ground on pins 18 through 25.
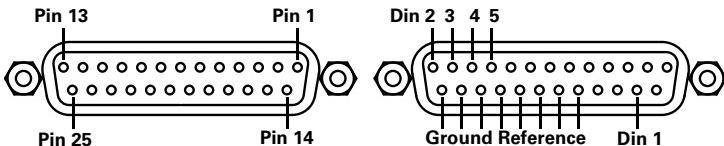
Din function.

Din	Parallel pin
1	15
2	13
3	12
4	11
5	10
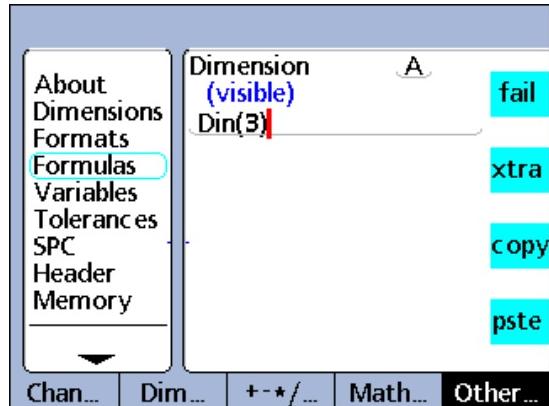
Din function syntax

A = **Din**(Pin number)
The logic level at a single Din pin is assigned to a dimension as a numeric 1 or 0.

A = **Din**(Range of pin numbers)
The decimal equivalent of the binary values from a range of pins are assigned to a dimension as a numeric value.

Example 1:

A = **Din**(3)

A = 1

When Din(3) = logic level 1

Example 2:

A = **Din**(3--5)

A = 20

When: Din(3) = logic level 1

Din(4) = logic level 0

Din(5) = logic level 1

Din	Din(5)	Din(4)	Din(3)	Din(2)	Din(1)
Din logic level	1	0	1	0	1
Decimal equiv.	16	0	4	0	1
	Specified range				

DinBin

Insert the DinBin function to read the logic levels of multiple parallel port input pins simultaneously as a decimal equivalent. The decimal value can be included directly in a dimension formula as a variable, or can be tested in conditional if and case statements.

To insert the DinBin function:

▶ Press the OTHER... soft key

▶ Press the XTRA dimension key

▶ Use the arrow cursor keys to highlight DinBin

▶ Press the ENTER key

DinBin function syntax

A = **DinBin**(Lines)

The logic levels at the Din pins are assigned to a dimension as a decimal value. Lines is a decimal value of the binary mask that specifies which input pins to read.

DinBin function.

Example:

A = **DinBin**(19)

Includes a lines value of 19, which when converted to a binary mask of 10011, reads Din(1), Din(2) and Din(5). All unread pins are given a logical value of zero. The binary value of the input pins read at the parallel port are then returned as a decimal equivalent.

A = **DinBin**(19)

A = 17

> When: When the input pin logic levels are 10101
>
> The lines mask value is decimal 19 = 10011
>
> The masked result is 10001 = decimal 17

Din	5	4	3	2	1
Din logic level	1	0	1	0	1
Lines mask (dec 19)	1	0	0	1	1
Masked value (dec 17)	1	0	0	0	1
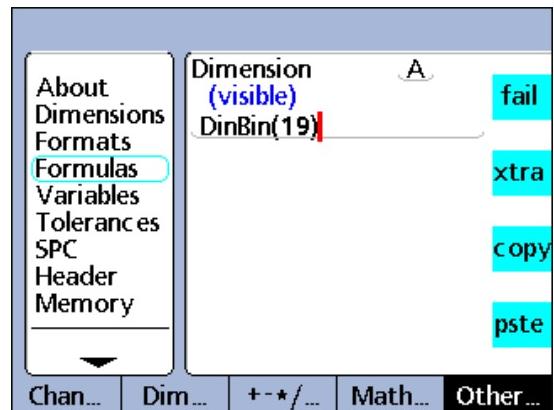
Dout and DoutBin function

The primary parallel port is configured as a general purpose data Input/Output (I/O) port, and does not support parallel printers.

The ND 2100G uses 12 of the parallel port connector pins as the outputs shown below. Outputs are 5 volt TTL logic levels.

> ➡ Electrical characteristics of the parallel port are described under Specifications on page 270.

Dout

Insert the Dout function to output a TTL logic level of 0 or 1 to a specific parallel port output pin or range of pins. Logic levels are referred to ground on pins 18 through 25. The logic level is presented to the pins specified, no other pins are affected. If a delay is also specified, the logic level will be presented for the delay period, and then the affected output pins will be changed to the opposite logic state.

To insert the Dout function:

▶ Press the OTHER... soft key
▶ Press the XTRA dimension key
▶ Use the arrow cursor keys to highlight Dout
▶ Press the ENTER key

The Dout pins of the parallel port connector are numbered 1 through 12.
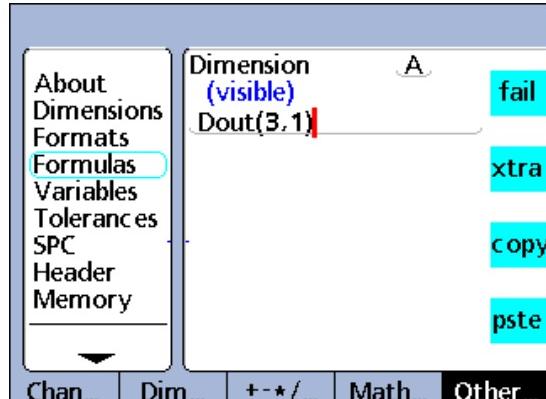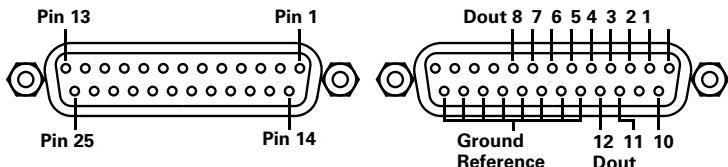
Dout function.

Dout	Parallel pin	Dout	Parallel pin
1	2	7	8
2	3	8	9
3	4	9	1
4	5	10	14
5	6	11	16
6	7	12	17

Dout function syntax

Hn = **Dout**(Pin number/range of pins, state, delay)

Where: Pin number/range of pins specifies which output pin or pins are used.

State is the logic level to output to the specified pins.

Delay is the output period in seconds - if a delay is not included, the output is continuous.

Example 1:

H1 = **Dout**(3,1)

H1 = Sets Dout pin 3 to a logical 1 continuously

Example 2:

H1 = **Dout**(3–5,1,5sec)

H1 = Sets Dout pins 3 through 5 to a logical 1 for 5 seconds, then to zero

DoutBin

Insert the DoutBin function to output a specified logic level to multiple parallel port output pins simultaneously. The new logic level can be presented continuously or for a specified period.

The logic level is presented to the pins specified by the lines mask, no other pins are affected. If a delay is also specified, the logic level will be presented for the delay period, and then the affected output pins will be changed to the opposite logic state.

To insert the DoutBin function:

▶ Press the OTHER... soft key

▶ Press the XTRA dimension key

▶ Use the arrow cursor keys to highlight DoutBin

▶ Press the ENTER key

DoutBin function.

DoutBin function syntax

Hn = **DoutBin**(Lines, state, delay)

Where: Lines is a decimal value of the binary mask that specifies which output pins are used.

            State is the logic level to output to the specified pins.

            Delay is the output period in seconds - if a delay is not included, the output is continuous.
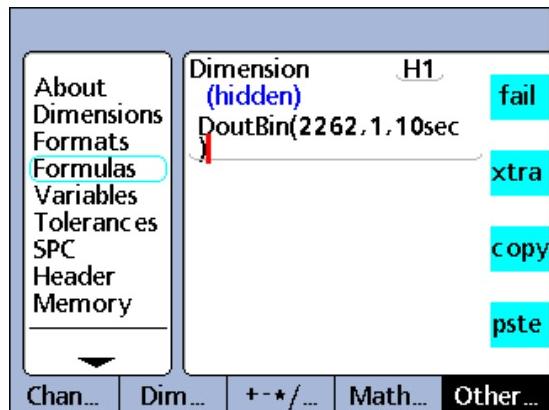
Example:

H1 = **DoutBin**(2262,1,10sec)

Includes a lines value of 2262, which when converted to a binary mask of 100011010110, outputs a logic level of 1 for 10 seconds to lines Dout(2), Dout(3), Dout(5), Dout(7), Dout(8) and Dout(12). All pins not included in the mask are unaffected. After the 10 second delay period, the affected output pins are changed to a logical 0.

H1 = **DoutBin**(2262,1,10sec)

When: When the lines mask is decimal 2262 = 100011010110.

The state is logical 1.

The delay is 10 seconds.

Outputs a logical 1 for 10 seconds as shown in this table.

Dout	12	11	10	9	8	7	6	5
State	1	1	1	1	1	1	1	1
Lines mask (dec 2262)	1	0	0	0	1	1	0	1
Resulting output	1	ua*	ua*	ua*	1	1	ua*	1

ua* = unaffected

Display function

The Display function sets the current graph display to a specified dimension and a specified number of axes. The display function should be used in other functions that are evaluated once, such as the OnEvent function.

To insert the Display function:

▶ Press the OTHER... soft key
▶ Press the XTRA dimension key
▶ Use the arrow cursor keys to highlight Display
▶ Press the ENTER key

Display function syntax

Hn = OnEventX(**Display**(dim,axes)

Where: dim = the dimension to display

axes = the number of graph axes to display
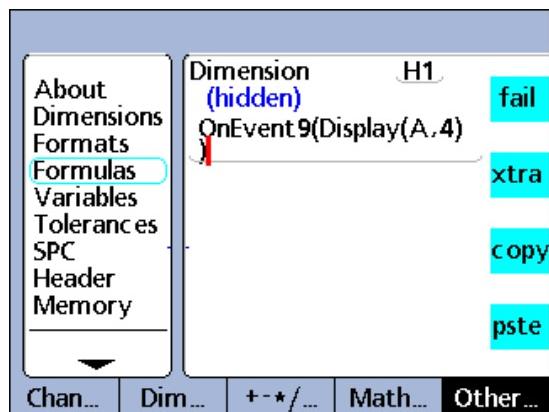
Display function.

Example:

H1 = OnEvent9(**Display**(A,4))
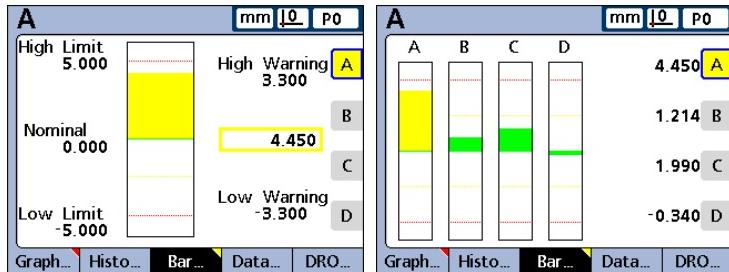
The display of graphs will change to show dimension A and a total of 4 axes when no numeric data is required and the 9 number key is pressed.

FnDefine, FnParam and FnCall functions

A custom ND 2100G function is a collection of formula operations that perform a specific task and is relatively independent of other formula operations. Calling a custom function in a formula returns a value calculated by the function.

Advantages to creating custom functions include:

- Reducing the duplication of formula operations in a part program

- Reuse of formula operations in multiple part program locations

- Compressing complex operations into short, simple statements that improve readability

ND 2100G custom functions always include:

- A collection of formula operations to be executed when the function is called

ND 2100G custom functions can also include:

- Parameters that are passed to the function and will be used in the calculation of the returned value

Custom functions are created using FnDefine. Custom functions that are passed parameters also use FnParam. Functions are executed when FnCall is included in a formula. Functions can be defined with or without input parameters and return the result of the included formula operations.

Functions must be defined on hidden dimension formula lines, but can be called from hidden or visible dimension formulas.

Defining and calling custom functions

To insert the define or call a custom function:

▶ Press the OTHER... soft key

▶ Press the XTRA dimension key

▶ Use the arrow cursor keys to highlight FnDefine or FnCall

▶ Press the ENTER key

FnDefine function syntax

Hn = **DefFn#**(action 1, action 2, …action n)
Actions are combinations of ND 2100G formula operations.

FnCall function syntax

A = **Fn#**(param1, param2, …param n)
Parameters are passed to the function and used to calculate the result.
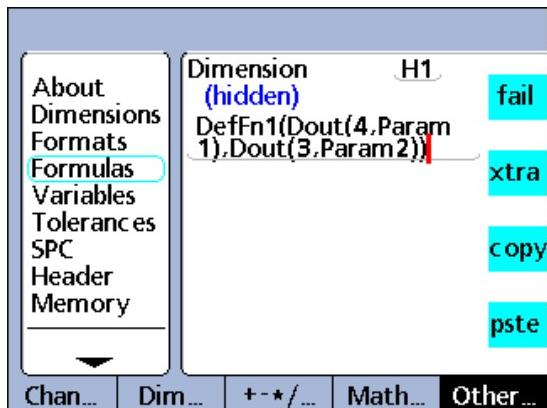
FnDefine function.
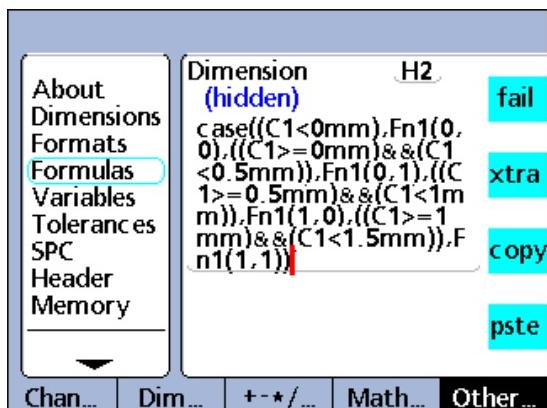
FnCall function.

Example:

A custom function is defined to change the logic state of parallel port output pins Dout(3) and Dout(4) to indicate four ranges of displacement of the channel 1 probe. The value ranges of C1 and the corresponding logic states of Dout(3) and Dout(4) are shown in this truth table.

C1 value range	Dout(4)	Dout(3)
<0 mm	0	0
>=0 mm AND <0.5 mm	0	1
>=0.5 mm AND <1.0 mm	1	0
>=1.0 mm AND <1.5 mm	1	1

This custom function is defined in a hidden dimension and uses 2 parameters to set the logic states of Dout(3) and Dout(4).

H1 = **DefFn1**(Dout(4,**Param1**),Dout(3,**Param2**))

Later, the function is called in a Case operation and the 2 parameters are passed in the calling statement that correspond to the logic states of Dout(3) and Dout(4) shown in the truth table above.

H2 = Case((C1<0mm),**Fn1(0,0)**,
   ((C1>=0mm)&&(C1<0.5mm)),**Fn1(0,1)**,
   ((C1>=0.5mm)&&(C1<1.0mm)),**Fn1(1,0)**,
   ((C1>=1.0mm)&&(C1<1.5mm)),**Fn1(1,1)**)

Variable and Global functions

Variables and Globals are used to:

■ Assign values to dimensions

■ Create loops or event counters to control the flow of logic

Variables

Variables are local to parts. For example, a variable used in part 0 will not be available in Part 1. Up to 20 variables can be used in each part.

To insert the Variable function:

▶ Press the OTHER... soft key

▶ Press the XTRA dimension key

▶ Use the arrow cursor keys to highlight Var

▶ Press the ENTER key

▶ Use the numeric keypad to enter the variable id

▶ Press the ENTER key

Setting the value of a variable

The method of setting the value of a variable depends on the application.

Syntax for setting the value of a variable

Var#(Value)

Examples:

Var1(ask!"Number")

The value is entered by the user in response to a prompt.

Var1(C1+sqr(C2+C3))

The value is calculated from the expression in parentheses.

Var1(27)

The value is set directly to the constant 27.

Reading the value of a variable

Variables can be tested by If and Case functions to count loop executions, indicate states and assign values to dimensions.

Syntax for reading the value of a variable

Var#( )

Example:
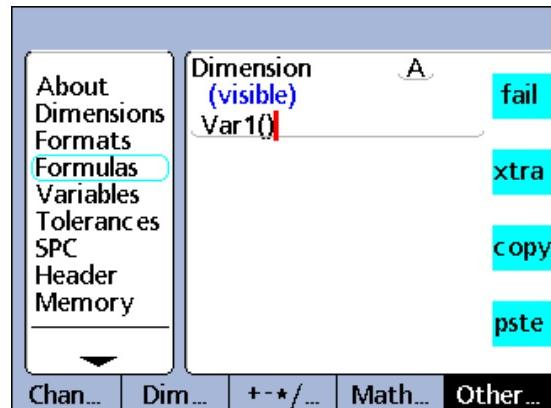
Var function.

Syntax for reading the value of a variable

A = **Var1**()

Assigns the value of Var1 to dimension A.

Variables as loop or event counters

Variables can be incremented or decremented to serve as loop or event counters. Incrementing a variable increases its value by a specified amount at each increment. Typically, a variable is incremented or decremented each time a loop is executed or an event occurs, and its value is tested to determine if the required number of loops or events have taken place.

Syntax for incrementing the value of a variable

Var#(Var#() + **increment value**)

Example:

Var1(Var1()+**1**)

Increments the value of variable Var1 by one.

Syntax for decrementing the value of a variable

Var#(Var#() - **increment value**)

Example:

Var1(Var1()-**1**)

Decrements the value of variable Var1 by one.

Globals

Globals are variables that are available to all parts in the system. For example, a global used in Part 0 will also be available in Part 1, or in any other part. Up to 20 globals can be used in the ND 2100G system. The Global function is identical in use and function to the Variable function described on the previous page.

To insert the Global function:

▶ Press the OTHER... soft key

▶ Press the XTRA dimension key

▶ Use the arrow cursor keys to highlight Global

▶ Press the ENTER key

▶ Use the numeric keypad to enter the variable id

▶ Press the ENTER key
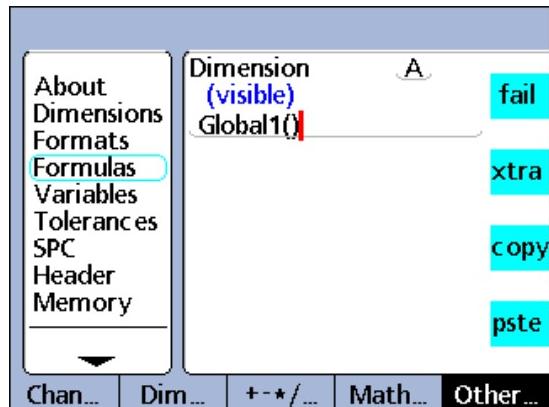
Global function.

Loop function

The loop function performs an evaluation or operation repeatedly through a specified number of execution loops.

To insert the Loop function:

▶ Press the OTHER... soft key

▶ Press the XTRA dimension key

▶ Use the arrow cursor keys to highlight Loop

▶ Press the ENTER key

Loop function syntax

Loop(number of loops, evaluation or operation)
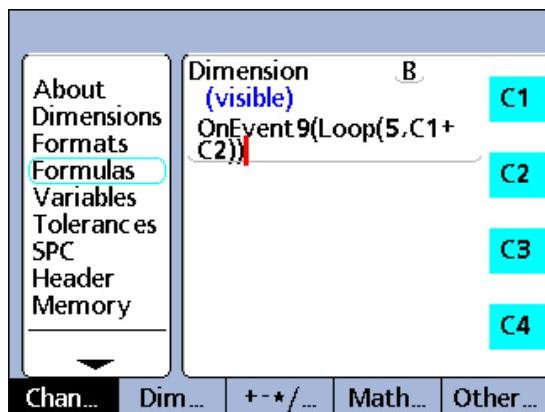
Loop function.

Example:

A = **Loop**(5,C1+C2)

Gets the sum of C1 and C2 5 times for every dimension evaluation.

The loop function must be contained by an OnEvent, Sequence or some other function, to prevent the loop from being executed continually at the dimension evaluation rate.

A = OnEvent9(**Loop**(5,C1+C2)

The loop execution is now constrained by the OnEvent function and will be executed only once when the number 9 key is pressed.

Remark function

The Remark function adds a comment to a formula, but does not affect values or operation. The comment can be added before or after the formula operations in visible dimensions, hidden dimensions and custom ND 2100G functions.

To insert the Remark function:

▶ Press the OTHER... soft key

▶ Press the XTRA dimension key

▶ Use the arrow cursor keys to highlight Remark

▶ Press the ENTER key

▶ Use the Alpha Entry screen to create a comment

▶ Press the FINISH key

Remark function syntax

A = /***Remark text***/formula or formulas/***Remark text***/
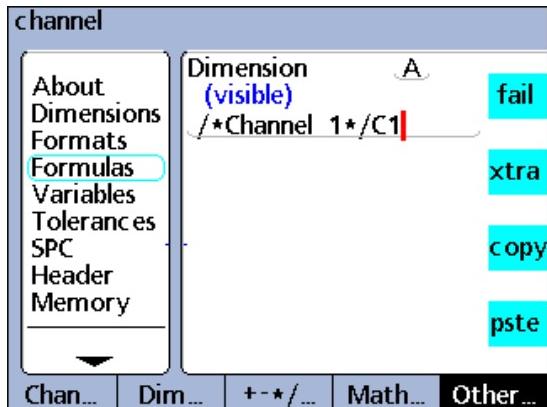
Remark function.

HwDmn and HwDmx functions

The HwDmn and HwDmx functions are identical to the dmin and dmax functions described earlier, except that only channel inputs are sampled, and the sample rates are very high.

To insert the HwDmn or HwDmx function:

▶ Press the OTHER... soft key
▶ Press the XTRA dimension key
▶ Use the arrow cursor keys to highlight HwDmn or HwDmx
▶ Press the ENTER key

The syntaxes of the HwDmn and HwDmx functions are also identical to the dmin and dmax functions discussed on page 215.

> Only encoder input channels can be used with the HwDmn and HwDmx functions.
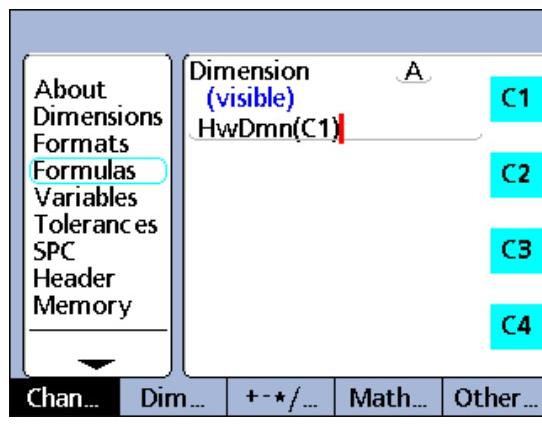
HwDmn function.

RsetDyn function

The RsetDyn function clears any existing dmin and dmax values, and must be used before assigning values using the dmin and dmax functions. The left wide hotkey above the screen is assigned the Dynamic Reset by default, and pressing this hotkey prior to a dynamic measurement will clear previous minimum and maximum values.

The Reset Dynamic function is also available in the Xtra menu for manual operation and for inclusion in formulas. Use of the Reset Dynamic function in formulas must be controlled by If, Case or OnEvent functions so that the reset only occurs when desired, and not repeatedly in every evaluation cycle.

To insert the RsetDyn function:

▶ Press the OTHER... soft key
▶ Press the XTRA dimension key
▶ Use the arrow cursor keys to highlight RsetDyn
▶ Press the ENTER key
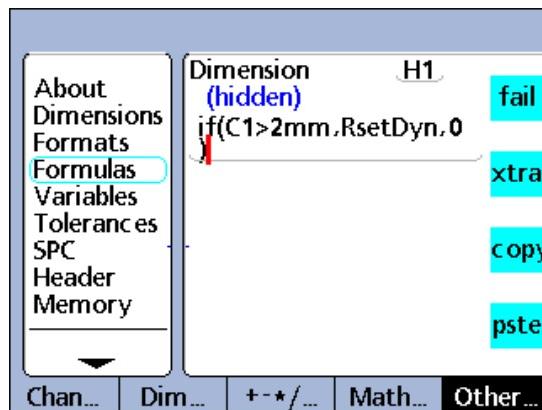
RsetDyn function.

HwLx function

The hardware latch (HwLx) function is used to include the value of one channel when a second reference channel reaches a specified value.

To insert the HwLx function:

▶ Press the OTHER... soft key

▶ Press the XTRA dimension key

▶ Use the arrow cursor keys to highlight HwLx

▶ Press the ENTER key

HwLx function syntax

A = **HwLx**(Chan #1, Chan #2, value)

This function assigns the value of channel #2 when channel #1 reaches the specified value.
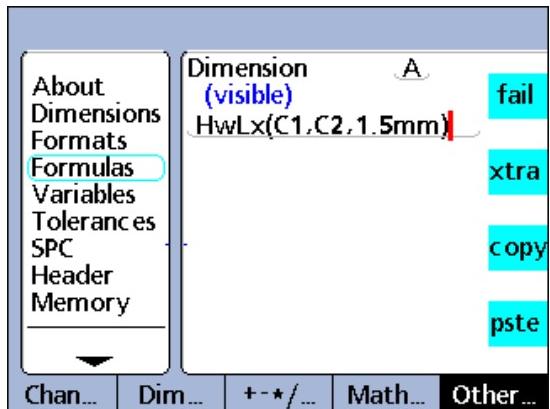
Example:

A = **HwLx**(C1,C2,1.5mm)

The rotational angle of the cam (C2) will be latched and the value assigned to dimension A when the cam lift (C1) is 1.5 mm.

HwLx function.
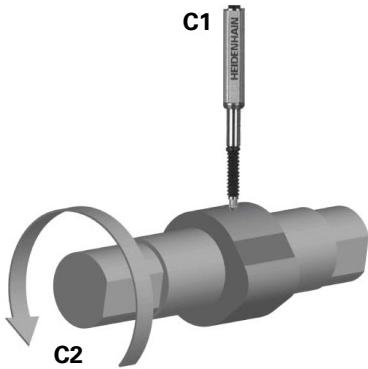
Lookup and data lookup

The Lookup function is used to include SPC, tolerance, database record and other information in formulas. The lookup function is used in If and Case functions to extend the system's tolerance capabilities.

The information that can be included in formulas using the Lookup function includes:

- BarMax: The Nom + Max value from the Tolerances screen
- BarMin: The Nom - Min value from the Tolerances screen
- Calc6Sig: The 6 Sigma value from the Data view screen
- CalcCp: The Cp value from the Data view screen
- CalcCpk: The Cpk value from the Data view screen
- CalcMax: The Max value from the Data view screen
- CalcMean: The Mean value from the Data view screen
- CalcMin: The Min value from the Data view screen
- CalcPp: The Pp value from the Data view screen
- CalcPpk: The Ppk value from the Data view screen
- CalcR: The r value from the Data view screen
- CalcRBar: The rbar value from the Data view screen
- CalcSig: The Sigma value from the Data view screen
- Datum: The current datum status 0/1; absolute/incremental
- HiLimit: The Nom + Limit value from the Tolerances screen
- HiWarn: The Nom + Warn value from the Tolerances screen
- IsDD, IsDMS: The current system angular units of measure
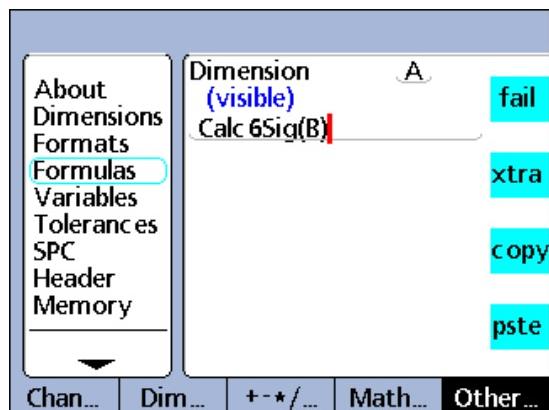
6 sigma lookup function.

- IsInch, IsMM: The current system linear units of measure

- MaxSGrp: The Max Subgroups value from the SPC screen

- NextId: The Next Record Id value from the SPC screen

- Nominal: The Nominal value from the Tolerances screen

- NumRecs: The number of records stored in the database for the current part

- LCL: The LCL value from the SPC screen

- LoLimit: The Nom - Limit value from the Tolerances screen

- LoWarn: The Nom - Warn value from the Tolerances screen

- RecDate, RecTime: The date and time that a specified record was stored in the ND 2100G database

- RLCL: The r Lcl value from the SPC screen

- RUCL: The r Ucl value from the SPC screen

- SGrpSize: The Subgroup size value from the SPC screen

- UCL: The UCL value from the SPC screen

- XBarLCL: The $\bar{x}$ Lcl value from the SPC screen

- XBarUCL: The $\bar{x}$ Ucl value from the SPC screen

To insert the Lookup function:

▶ Press the OTHER... soft key

▶ Press the XTRA dimension key

▶ Use the arrow cursor keys to highlight Lookup

▶ Press the ENTER key

▶ Use the arrow cursor keys to highlight the desired Lookup option

▶ Press the ENTER key

Example:

A = **Calc6Sig**(B)

A = 0.0345 when the 6 Sigma for dimension B is 0.0345 in the Data View screen.

Data lookup function

The data lookup function is used to assign a value from the database of stored dimension values to a dimension, or to include it as the criterion of a comparison test. The data lookup function does not appear in any menu and must be constructed of a dimension label and parentheses containing record and part indexes as shown in the syntax example below:

Data lookup function syntax

C = **A(Record index,part index)**

When no part index is specified, the current part records are used.

Database record elements are numbered starting with element 0 at the top of the list for each dimension. The most recently stored value is at the top. Value A(2) is the third element from the top of dimension A list (not the second) as shown below.

List indexes must be positive integers. An index that exceeds the range of a specified list results in an error message.

Example 1:

C = **A(2)**
C = 2.314

	9.33.13 AM 9-29-08		mm 10 P0
	#27 2.314		

	A	B	C	D	
A(0)	2.346	1.311	2.735	1.117	A
	2.379	1.343	2.799	1.181	
A(2)	2.314	1.311	2.767	1.117	B
	2.282	1.278	2.702	1.052	
	2.476	1.149	2.767	0.922	
	2.346	1.019	2.605	0.728	C
	2.314	1.084	2.767	0.663	
	2.055	0.922	2.961	0.469	
					D

| Graph... | Histo... | Bar... | Data... | DRO... |

Example 1.

Example 2:

C = **B(2,3)**
C = 0.858

Shows the syntax of a data lookup function that uses record and part indexes.

The formula assigns the value of the third element of the data stored for dimension B of part 3 to dimension C.

	9.56.20 AM 9-29-08		mm 10 P3
	#5 1.537		

	A	B	C	D	
	1.375	0.858	1.375	1.149	A
	1.472	0.825	1.505	1.117	
	1.537 B(2)	0.858	1.570	1.214	B
	1.505	0.793	1.570	1.149	
	1.634	0.955	1.667	1.311	
	1.537	0.858	1.570	1.181	C
	1.634	0.566	1.699	1.019	
					D

| Graph... | Histo... | Bar... | Data... | DRO... |

Example 2.

Master function

The Master function is used to perform a master calibration of input channel groups in response to remote I/O signals on the parallel port, key presses or, more rarely, tests performed in formulas. Mastering with remote I/O and key presses is implemented using the OnEvent function.

The input channel mastering uses values previously entered into master groups and the mastering type specified in the Master setup screen described earlier in this chapter; Mean or Min-Max. The Mean mastering type performs either a Min or Max channel preset at the current input probe position. Min-Max mastering performs a channel preset followed by a resolution calibration.

The order of Min-Max mastering operations can be Min preset followed by a Max to calibrate resolution, or a Max preset followed by a Min to calibrate resolution. In either case, the mastering type should be changed to Mean in the Master setup screen once the resolution is calibrated to prevent accidental recalibration when a new preset is performed.

To insert the Master function:

▶ Press the OTHER... soft key
▶ Press the XTRA dimension key
▶ Use the arrow cursor keys to highlight Master
▶ Press the ENTER key. You will be prompted for the Min or Max preset type and the master group number.
▶ Press the MIN or MAX soft key
▶ Use the numeric keypad to specify the Group Number to master
▶ Press the OK soft key
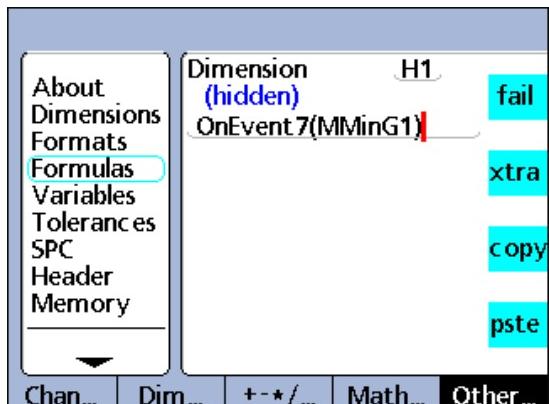
Master function in OnEvent function.

MaxIndex and MinIndex functions

The MaxIndex and MinIndex functions return the position of either the minimum or maximum value in a list. The list can contain individual values, ranges of values or a mixture of both.

In the list:	(12,34,23,67,13)	The position of the maximum value is 4.
	(2,45,27,41,56)	The position of the minimum value is 1.
	(C1–C4,7,A,6,4)	The position of the maximum value is 1.

When: C1 = 2.0 C4 = 8.2

C2 = 5. A = 3.8

C3 = 2.1
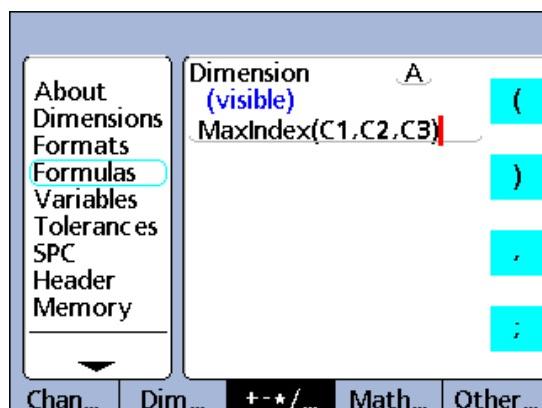
MaxIndex function.

To insert the MaxIndex or MinIndex function:

▶ Press the OTHER... soft key
▶ Press the XTRA dimension key
▶ Use the arrow cursor keys to highlight MaxIndex or MinIndex
▶ Press the ENTER key

MaxIndex function syntax

A = **MinIndex**(List of values or ranges)

Example:

A = **MinIndex**(C1,C2,C3)

A = 2 When C1 = 2.5, C2 = 1.5, C3 = 3.7

MaxIndex function syntax

A = **MaxIndex**(List of values or ranges)

Example:

A = **MaxIndex**(C1,C2,C3)

A = 3 When C1 = 2.5, C2 = 1.5, C3 = 3.7

PartNo function

The PartNo function is used to change part numbers from within a formula. The ND 2100G database provides storage for up to 16 dimensions for each part. Applications involving more than one physical part or requiring greater than 16 dimensions can use multiple parts to provide additional database capacity.

To insert the PartNo function:

▶ Press the OTHER... soft key
▶ Press the XTRA dimension key
▶ Use the arrow cursor keys to highlight PartNo
▶ Press the ENTER key
▶ Use the numeric key pad to specify the desired part number
▶ Press the OK soft key

PartNo function in OnEvent function.

PartNo function syntax

A = Formula;**PartNo**
Assigns the function to a visible dimension. See Example 1.

H1 = **PartNo**
Assigns the function to a hidden dimension.

H1 = Function(**PartNo**)
Assigns the function to a hidden dimension within another function. See Example 2 and 3.

Example 1:

A = C4;**Part2**

A = C4 and changes the current part to part number 2.

Example 2:

H1 = OnEventWide 1(**Part2**)

Changes the current part to part number 2 when the LEFT WIDE key is pressed.

Example 3:

Users are given access to parts in the ND 2100G by password.

H2 = ask1"Pass"

The user is prompted for a password

H3 = Case(H2==1234,Part1,H2==5678,Part2,,Part3)

Password 1234 causes part 1 to be active.

Password 5678 causes part 2 to be active.

Any other password causes part 3 to be active.

Preset function

The Preset function is used to preset a dimension to a specified value.

To insert the Preset function:

▶ Press the OTHER... soft key

▶ Press the XTRA dimension key

▶ Use the arrow cursor keys to highlight Preset

▶ Press the ENTER key

Preset function syntax

A = Formula;Preset(Dimension,value)
Assigns the function to a visible dimension. See Example 1.

H1 = Preset(Dimension,value)
Assigns the function to a hidden dimension.

H1 = Function(Preset(Dimension,value))
Assigns the function to a hidden dimension within another function.
See Example 2.
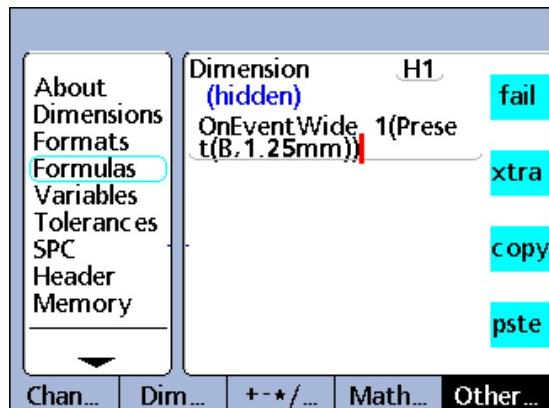
Preset function in OnEvent function.

Example 1:

A = C1;**Preset**(B,1.25mm)

A = C1 and dimension B is preset to 1.25 mm

Example 2:

H1 = OnEventWide 1(Preset(B,1.25mm))

Presets dimension B to 1.25 mm when the LEFT WIDE key is pressed.

Recall function

The Recall function is used to reestablish the last dimension preset value or values specified using the Preset function. All dimension presets last applied will be recalled. The Recall function is generally included in an OnEvent, If or Case function.

To insert the Recall function:

▶ Press the OTHER... soft key
▶ Press the XTRA dimension key
▶ Use the arrow cursor keys to highlight Recall
▶ Press the ENTER key

Recall function syntax

A = Formula;**Recall**
Assigns the function to a visible dimension. See Example 1.

H1 = **Recall**
Assigns the function to a hidden dimension.

H1 = Function(**Recall**)
Assigns the function to a hidden dimension within another function. See Example 2.

Example 1:

A = C1;Recall

A = C1 and all the latest dimension presets are recalled as current presets.

Example 2:

H1 = OnEventWide 1(Recall)

Recalls the most recent dimension presets when the LEFT WIDE key is pressed.
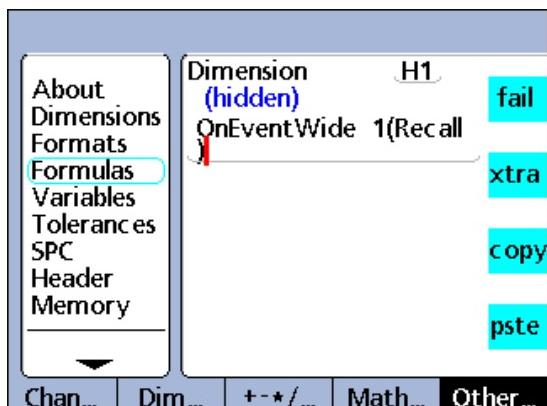
Recall function in OnEvent function.

Relay function

The Relay function provides formula control of electrical relay contact operation.

The contacts of two single-pole, double-throw dry-contact relays are accessible on the rear of the ND 2100G for special applications requiring low-power electrical switching. The normally open and normally closed contacts of both relays are available for use in low-current, low-voltage applications. Refer to "Specifications" on page 270.

The relay function can be used by itself or included in if or case statements as the logical result of either passing or failing a comparison test.

To insert the Relay function:

▶ Press the OTHER... soft key
▶ Press the XTRA dimension key
▶ Use the arrow cursor keys to highlight Relay
▶ Press the ENTER key

8 Pin conn.	Signal
1	Relay 1 Input
2	Relay 1 Normally Closed
3	Relay 2 Normally Open
4	Relay 1 Normally Open
5	Relay 2 Normally Closed
6	Relay 2 Input
7	-
8	-

8 PIN DIN (Male)

De-energized

Input
Normally open
Normally closed

Energized

Input
Normally open
Normally closed
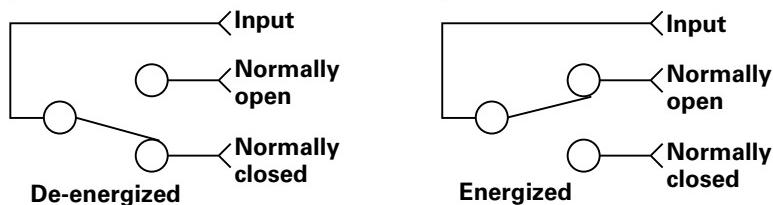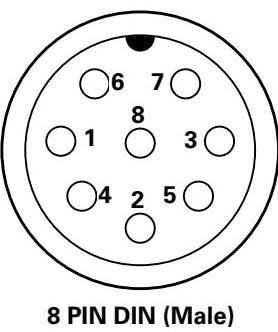
Relay function syntax appended to a formula

A = Formula;**Relay**(Relay number, state, delay)

Where: Relay number = 1 or 2.

State = 0 (off/low/de-energized) or 1 (on/ high/energized).

Delay = The time in seconds that the relay will be in the new state before returning to the previous state.

Example:

A = C3;**Relay**(1,1,2sec)

A = C3 and Relay number 1 will be energized for 2 seconds.
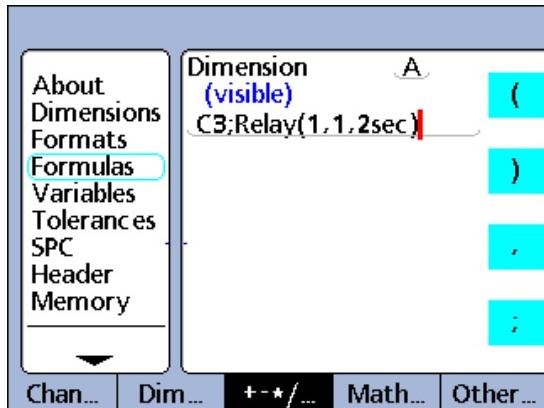
Relay function appended to formula.

Report function

The Report function is used to print reports on the USB port. Contents can include a user specified range, all new records (never before reported), all records or a record selected in the data view.

To insert the Report function:

▶ Press the OTHER... soft key

▶ Press the XTRA dimension key

▶ Use the arrow cursor keys to highlight Report

▶ Press the ENTER key

▶ Press the RANGE, NEW, ALL or SELECTED soft key to select the data you want printed

Report function syntax

A = Formula;**Report**
Assigns the function to a visible dimension. See example 1.

H1 = **Report**
Assigns the function to a hidden dimension.

H1 = Function(**Report**)
Assigns the function to a hidden dimension within another function. See example 2.
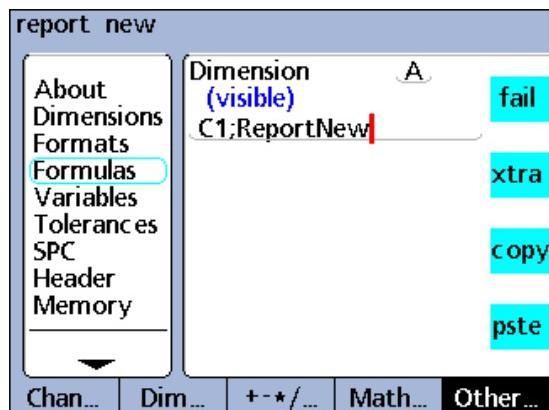
Example 1:

A = C1;**ReportNew**

A = C1 and a report is printed of new records.

Example 2:

H1 = OnEventWide 1(**ReportNew**)

Prints a report of new records when the LEFT WIDE key is pressed.

Report function.

Scan function

The scan function rapidly collects potentially large quantities of measurement data from all input channels simultaneously. When the scan function is initiated, all channel inputs are collected in a series of data records that are stored in a temporary memory buffer. No data are displayed on the DRO and no formulas are evaluated during the scanning period. This process is explained in detail below and shown by the flowchart on the next page.

Scan function syntax

Scan (ch, st, inc, dp, to)

Parameters specified for the scan function include:

- ch (Reference channel): Scans of all channels are collected at predetermined intervals that are measured by the reference channel

- st (Starting value): Scans begin when the reference channel measurement reaches this value

- inc (Scanning increment): A new scan is performed each time the reference channel value increases (or decreases) by this increment value. The scans continue only when the increments progress in the same direction (+ or -) over the scanning cycle.

- dp (Depth of scans): Scans are accumulated in a temporary buffer memory until the specified depth (number) of scans has been collected, or until the timeout interval has elapsed

- to (Timeout interval): Scanning is aborted if the timeout interval expires before the specified depth of scans have been collected. A RsetDyn function must be performed before the Scan function can be used again.

When scanning begins, the reference channel value (ch) is compared to the Starting value (st) parameter. When the reference channel value reaches the starting value, all channel inputs are scanned once and stored in a temporary memory buffer. The system then waits for the reference channel value to cross the first increment above (or below) the starting value.

Send function in OnEvent function.

All channel values stored and system waits for first incremental value.

```
                    ┌──────────────────┐
                    │  Scan function   │
                    └──────────────────┘
                              │
                    ┌─────────────────┐
                    │ Reference channel│──NO──┐
                    │value reach start │      │
                    │     value?       │      │
                    └─────────────────┘       │
                           │YES
                    ┌──────────────────────┐
                    │ Scan all input channel│◄─────YES─┐
                    │ values into temporary │          │
                    │  buffer memory        │    ┌─────────────────┐
                    └──────────────────────┘    │Reference channel │
                              │                  │value move in the │
                    ┌─────────────────┐          │same direction to │
                    │ Number of scans  │──NO──┐  │next increment?   │
                    │    =depth?       │      │  └─────────────────┘
                    └─────────────────┘      └──NO──┘
                           │YES
                    ┌──────────────────┐
                    │ Stop scanning    │
                    │ input channels   │
                    └──────────────────┘
                              │
                    ┌──────────────────────┐
                    │ Playback one data    │
                    │ record               │
                    └──────────────────────┘
                              │
                    ┌──────────────────────┐
                    │ Generate playback    │
                    │ event                │
                    └──────────────────────┘
                              │
                    ┌─────────────────┐
                    │ All records     │──NO──┐
                    │ played back?    │      │
                    └─────────────────┘      └──┘
                           │YES
                    ┌──────────────────┐
                    │ END scan function│
                    └──────────────────┘
```

Scanning

All input channel values are scanned into a buffer memory.

The scan function is aborted if a timeout occurs before the specified depth of scans has been collected.

A RsetDyn function must occur before using the scan function.

Playback

Records of scanned channel data are played back to the DRO.

A playback event is generated with each record.

Each time the value of the reference channel increases or decreases by the specified increment (inc), another scan of all input channels is collected and stored in the temporary buffer. Input channel scanning continues in this manner at each new increment until the specified depth of scans (dp) is collected.

Reference channel values between increments are irrelevant to the process as long as the values pass through increments in one direction.

The scan function is aborted if the timeout interval (to) elapses before the specified depth of scans is collected.

When the specified depth of scans has been collected, the channel data are immediately played back and displayed on the DRO in the order they were scanned. A playback event is generated each time a record is played back. This playback event is used in conjunction with the OnEvent function to enter the scanned data into the ND 2100G database, include the data in the formulas or send the data to a computer. A RsetDyn function must be performed to clear the buffer before the Scan function can be used again.
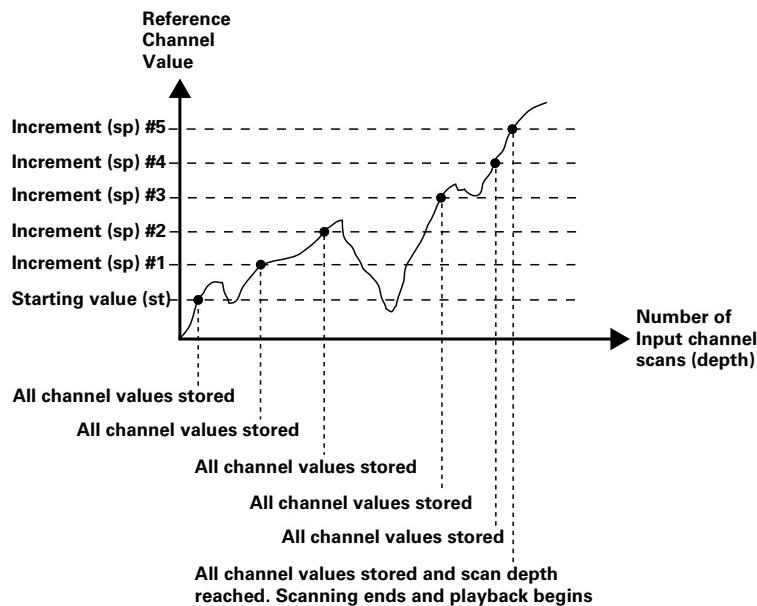
Scanning input channels

The scan function is generally included in another function as an operation to be performed in response to a condition or an event.

Scan function syntax within another function

H1 = Function(**Scan**(ch, st, inc, dp, to))

In the following two examples, camshaft lift profiles will be measured at 1 degree intervals over 360 degrees of rotation using a reference channel rotary encoder and three cam encoders.

In these examples, the number 5 key is pressed to generate an event that initiates scanning.
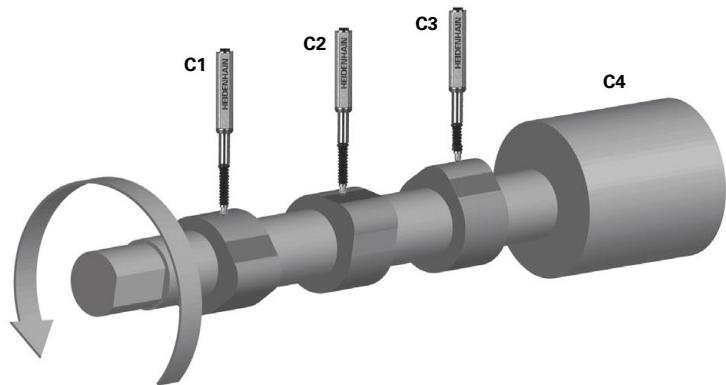
The method of playing back scanned data is unique to each of the two examples. However, in both cases, the OnEvent function is used to route the data.

Example 1: Scanning data to the ND 2100G database.

The channels are scanned and then entered into the database using the Trip function and Playback event. Scanning is initiated by pressing the number 5 key, and then 360 scans are collected at 1 degree increments. If all the specified scans are not complete within the timeout period of 60 seconds, the scan function is aborted. During playback, each time a Playback event occurs, a record of dimension values is entered into the ND 2100G database.

H1 = OnEvent5(Scan(C4,0Deg,1Deg,360,60sec))

A = C1
B = C2
C = C3
D = C4
H2 = OnEventPlayback(Trip(,,,))

Example 2: Scanning data to the RS-232 serial port.

The channels are scanned and then transmitted to the RS-232 serial port using the SendRec function and Playback event. Scanning is initiated by pressing the number 5 key, and then 360 scans are collected at 1 degree increments. If all the specified scans are not complete within the timeout period of 60 seconds, the scan function is aborted. During playback, each time a Playback event occurs, a record of dimension values is transmitted to the RS-232 serial port.

H1 = OnEvent5(Scan(C4,0Deg,1Deg,360,60sec))

A = C1
B = C2
C = C3
D = C4
H2 = OnEventPlayback(SendNewRec)

Send function

The Send function is used to transmit the current value of the formula's dimension or other numeric data over the USB or RS-232 serial port. USB and serial ports are configured for transmissions in the USB and RS-232 setup screens.

To insert the Send function:

▶ Press the OTHER... soft key

▶ Press the XTRA dimension key

▶ Use the arrow cursor keys to highlight Send

▶ Press the ENTER key

Send function syntax

A = Formula;**Send**
Appends the Send function to a visible dimension formula. See example 1.

A = Formula;**Send(number,display resolution)**
Extends the syntax of the Send function to transmit the value of a number (constant) that can be evaluated as a number, and can also include display resolution formatting.

A = Formula;**Send(expression,display resolution)**
Extends the syntax of the Send function to transmit the value of an expression that can be evaluated as a number, and can also include display resolution formatting. See example 2.

H1 = **Send** - Assigns the Send function to a hidden dimension.

H1 = Function(**Send**) - Assigns the Send function to a hidden dimension within another function.

Example 1:

A = C4;**Send**

A = C4, and dimension A data is transmitted to a port.

Example 2:

A = C1;**Send((B+D),0.001)**

A = C1 and the value of the expression (B+D) is transmitted to a port with 3 decimal places.

Example 3:

H1 = OnEventWide 1(**Send**)

Transmits data to a port when the LEFT WIDE key is pressed.
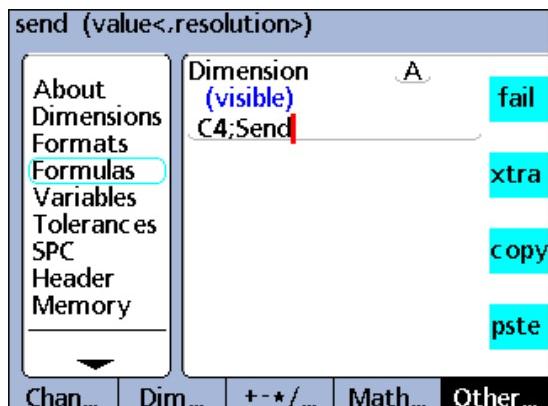
Send function appended to a visible dimension.

SendMsg function

The Send Msg function is used to transmit text or ASCII codes over the RS-232 port.

Text messages and ASCII codes are entered into the Alpha Entry screen.

To insert the SendMsg function:

▶ Press the OTHER... soft key
▶ Press the XTRA dimension key
▶ Use the arrow cursor keys to highlight SendMsg
▶ Press the ENTER key
▶ Use the Alpha Entry screen to create a message

or

▶ Press the ASCII soft key to enter ASCII codes into the Alpha Entry screen
▶ Press the FINISH key
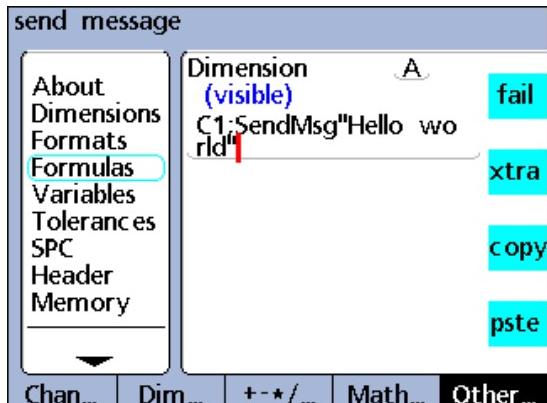
SendMsg function appended to a visible dimension.

SendMsg function syntax

A = Formula;**SendMsg**
Appends the SendMsg function to a visible dimension formula. See example 1.

H1 = **SendMsg**
Assigns the SendMsg function to a hidden dimension.

H1 = Function(**SendMsg**)
Assigns the SendMsg function to a hidden dimension within another function. See example 2.

Example:1

A = C1;**SendMsg**"Hello world"

A = C1 and the message "Hello world" is transmitted to the RS-232 port.

Example 2:

H1 = OnEventWide 1(**SendMsg**)

Transmits a message when the LEFT WIDE key is pressed.

SendRec function

The SendRec function is used to send records over the USB or RS-232 (serial) ports.

➡ USB and serial ports are configured for transmissions in the USB and RS-232 setup screens.

SendRec function appended to a visible dimension.

To insert the SendRec function:

▶ Press the OTHER... soft key
▶ Press the XTRA dimension key
▶ Use the arrow cursor keys to highlight SendRec
▶ Press the ENTER key
▶ Press the RANGE, NEW, ALL or SELECTED soft key to select the data you want printed

SendRec function syntax

A = Formula;**SendRec**
Appends the SendRec function to a visible dimension formula. See example.

H1 = **SendRec**
Assigns the SendRec function to a hidden dimension.

H1 = Function(**SendRec**)
Assigns the SendRec function to a hidden dimension within another function. See example 2.

Example:1

A = C4;**SendRec**

A = C4 and record data is transmitted.

Example 2:

H1 = OnEventWide 1(**SendRec**)

Transmits record data when the LEFT WIDE key is pressed.

SetColor function

The SetColor function is used to set the DRO display color of a single dimension. The SetColor function only changes colors in the DRO screen, and has no affect on other screens. The color of a dimension can be changed to highlight the result of an If test or Case sort, or to emphasize some other state or condition.

To insert the SetColor function:

▶ Press the OTHER... soft key
▶ Press the XTRA dimension key
▶ Use the arrow cursor keys to highlight SetColor
▶ Press the ENTER key
▶ Use the arrow cursor keys to highlight the desired color
▶ Press the ENTER key

SetColor function syntax

Hn = **SetColor**(Dimension)

Setcolor function.

Example:

H1 = **SetColor**(A)

Select cyan in response to prompt,.

H1 = Cyan(A)

Dimension A is displayed in cyan on the DRO.

Setup function

The Setup function is used to specify bar graph parameters for the current part including:

- Max value (BarMax)
- Min value (BarMin)
- High limit (HiLimit)
- High warning (HiWarn)
- Low limit (LoLimit)
- Low warning (LoWarn)
- Nominal value (Nominal)

To insert the Setup function:

▶ Press the OTHER... soft key
▶ Press the XTRA dimension key
▶ Use the arrow cursor keys to highlight Setup
▶ Press the ENTER key
▶ Use the arrow cursor keys to highlight the desired bar graph parameter
▶ Press the ENTER key
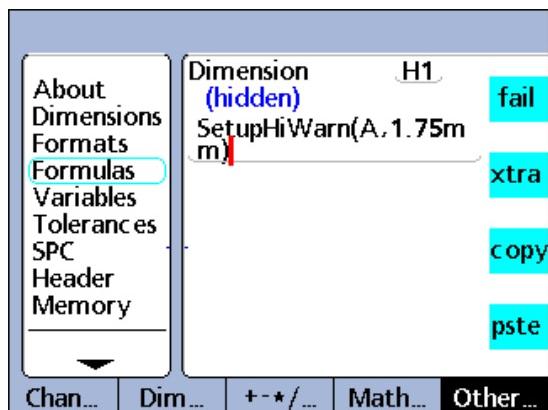
Setup function.

Setup function syntax

Hn = **Setup**Parameter(Dimension,value)

Example:

H1 = **Setup**HiWarn(A,1.75mm)

H1 = **Setup**HiWarn(B,2.00mm)

H1 = **Setup**HiWarn(C,2.25mm)

H1 = **Setup**HiWarn(D,2.50mm)

Sets the Bar graph high warning parameters of dimensions A through D to different values.

Xlatch function

The XLatch function is used to latch and assign the value of a channel to a dimension when an edge is detected on an optional edge detection input.

➡️ The XLatch function is available only when the edge detection option is specified for the ND 2100G at the time of purchase. This option cannot be installed in the field.

Edge detection and relay functions alternately use the same connector located on the ND 2100G rear panel. When the edge detection option is included, relay output functions are not available.

To insert the Xlatch function:

▶ Press the OTHER... soft key
▶ Press the XTRA dimension key
▶ Use the arrow cursor keys to highlight Xlatch
▶ Press the ENTER key

Xlatch function.

Xlatch function syntax

A = **XLatch**(Channel, edge line #, auto trip)

Edge lines:		Auto trip;	
1	Single edge option	**1**	Auto trip enabled.
2	First of two for double edge option	**0**	Auto trip disabled
3	Second of two for double edge option		
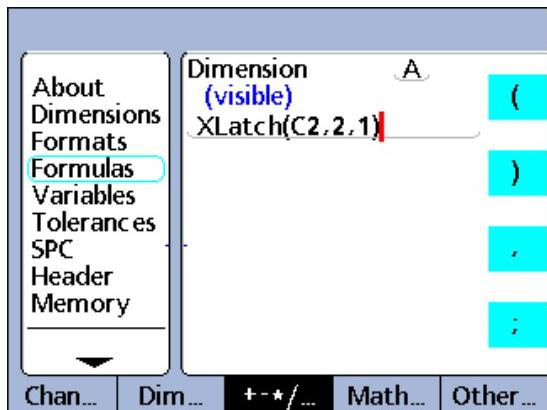
A Trip function event can be initiated to automatically enter the latched channel value into the ND 2100G database when an edge is detected by enabling auto trip in the formula function.

Example:

The horizontal position of a label on a box will be measured by latching the value of C1 when the label edge is recognized by a photoelectric sensor C2 connected to edge line # 2. When the edge of the label is detected, dimension A is automatically entered into the ND 2100G database by an auto trip event.

A = **XLatch**(C1,2,1)
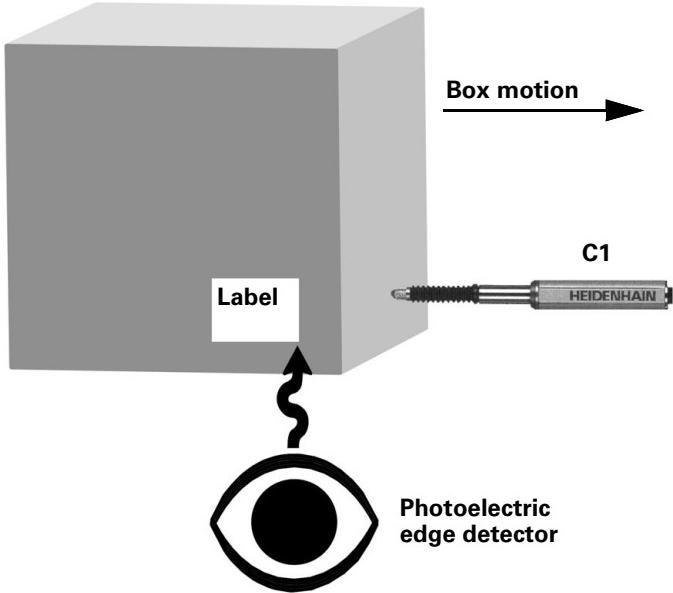
2.5 Specifications

Specifications	
Channel inputs	■ 1, 4 or 8 single-input channels
	■ Up to 16 networked RS-232 input channels
	■ Combinations of single-input channels and networked RS-232 input channels for a total of up to 16 channels
Display	Color LCD
	■ 5.7″ (14.48 cm)
	■ 0.50″ (1.27 cm) display digit size
	■ 0.000004″ (0.00001 mm) Resolution
Error compensation	Linear (LEC), segmented linear (SLEC)
Data interfaces	Serial interfaces
	■ RS-232-C
	■ USB 2.0 Type A Full-speed
Optional accessories	■ Remote foot switch
	■ Remote keypad
	■ ND 2100G Protective cover
	■ QUADRA-CHEK Wedge communication software
Main power input	100 Vac to 240 Vac; 50 to 60 Hz
Line fuse	1.6 Amp, 250 V slow blow; 5 X 20 mm
Output relay	■ Switching voltage 100V Max DC
	■ Switching current 0.25A Max DC
	■ Carry current 0.5A Max DC
	■ Contact rating 3W Max DC
ENC testing	■ EN61326: 1998 EMC for electrical equipment for measurement, control and laboratory use
	■ EN61010: Safety requirements for electrical equipment for measurement, control and laboratory use
Installation category	II
Environmental	■ Temperature: 32 °F to 113 °F (0 °C to 45 °C) non-condensing
	■ Relative air humidity: 90%
	■ Altitude: 6562 feet (2000 meters)
Enclosure	Benchtop; cast-metal enclosure

Specifications	
Dimensions	■ Enclosure (W x H x D): 11.5″ X 7.5″ X 2.75″ (29.21cm X 19.05 cm X 6.99 cm)
	■ Base (W x H x D: 10″ X 2″ X 7.8″ (25.4 cm X 5.8 cm X 19.81 cm)
Weight	■ Enclosure: 3.5 lbs (1.6 kg)
	■ Base: 7 lbs (3.2 kg)

Dimensions

The ND 2100G enclosure, tray stand and arm mount bracket dimensions are shown in the format: mm.

Arm mount bracket

B

M6.3 - 1.3 x 16.5
(1/4 - 20" x 0.65")

125

38

43.5

27.5

55

203.5

B

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HEIDENHAIN